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ANNUAL REPORTS

OF THE

DEPARTMENT OF AGRICULTURE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1905.

REPORT OF THE

SECRETARY OF AGRICULTURE.

DEPARTMENTAL REPORTS.

WASHINGTON:
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

To THE PRESIDENT:

I have the honor to submit herewith my Ninth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

The well-being of the American farmer is a matter of profound interest to the entire country. It is, therefore, in the highest degree gratifying to present for your consideration the following evidences of the unprecedented prosperity which has in this and recent years rewarded the diligence of the farmer and the efforts of this Department on his behalf.

FARMER'S WEALTH AND WELL-BEING.

UNSURPASSED PROSPERITY.

Another year of unsurpassed prosperity to the farmers of this country has been added to the most remarkable series of similar years that has come to the farmers of any country in the annals of the world's agriculture. Production has been unequaled; its value has reached the highest figure yet attained; the value of the farmers' National surplus still maintains the magnitude that has built up the balance of trade by successive additions for many years sufficient to change the Nation from a borrower into a lender; there is a continuation of the unprecedented savings that have embarrassed local banks with their riches and have troubled farmers to find investments; and, as if all of these manifestations of a high degree of well-being were not enough, the farms themselves have increased in value to a fabulous extent.

Farm crops have never before been harvested at such a high general level of production and value. The partial failure of two or three second-class crops makes no apparent impression upon the great aggregate of all crops.

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After much laborious collection of information an estimate of the value of the crops of 1905 and of all other farm products has been made, as was done last year. The census's detailed statement of the value of all farm products was taken as the basis, and the various items have been brought down from year to year in their quantities and values. For such crops as will later receive a final estimate by the Bureau of Statistics of this Department, the figures herein used are subject to small correction. All values adopted for the various products are farm values, and are in no wise to be mistaken for exchange, middleman's, or consumer's values.

HIGH CROP VALUES.

Corn has reached its highest production with 2,708,000,000 bushels, a gain of 42,000,000 over the next lower year, 1899. In value, also, the corn crop of this year is higher than that of the next lower year, 1904, by $128,000,000, and the total value may be $1,216,000,000. No other crop is worth more than half as much.

Hay.—Second in order of value among all kinds of crops is the hay crop, which takes the second place back from the cotton crop, which held it for the two preceding years. Many hay crops have exceeded in tons the product of this year, but because of high prices the crop reaches a value of $605,000,000, which is higher by $34,000,000 than the value of the crop of 1893.

Cotton, including seed, stands third in value among the leading crops of the year, although some uncertainty still remains concerning its quantity and value. It can only be said that its value, including seed, is expected to rise well toward $575,000,000, and will be nearer to that figure, or above it, in proportion as the expectations of cotton planters are realized with regard to higher prices.

Wheat.—Fears last year that the United States had fallen to the level of its consumption in the production of wheat were ill-founded. The short crop of that year is followed this year by the second wheat crop in size that this country has ever produced, 684,000,000 bushels, and the value of this crop, $525,000,000, overtops the highest value before reached, in 1891, by $11,000,000.

Oats.—Fifth in order of value among the crops of the year is the oat crop, with 939,000,000 bushels, or 50,000,000 bushels under the highest production, in 1902. In value as well as yield the oat crop of this year has been exceeded in only two previous years, amounting to $282,000,000, only $22,000,000 under that of 1902.

Potatoes.—Next after oats comes the potato crop, which has been a partial failure and falls below the highest production of preceding years, that of 1904, by 72,000,000 bushels; but in value the crop has

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done better, since it occupies the fourth place from the highest, and is valued at $138,000,000, or only $13,000,000 below the highest preceding value, that for 1903.

Barley.—The high price of barley during the last three years has much increased the size and value of this crop, so that it now occupies seventh place among the leading agricultural crops. In quantity the crop of this year, 133,000,000 bushels, is third among annual barley crops, though only 7,000,000 bushels under the highest crop, that of 1904, and has a value of $58,000,000, or only $4,000,000 under the most valuable crop of this cereal, that of 1902.

Tobacco, like potatoes, is an undersized crop this year, as it was last year, and, considering the difficulties in the way of placing a value upon it at this time, an estimate of $52,000,000 may be too low. At any rate, because of high prices, the entire crop almost exceeds the highest value yet reached, that of 1899.

Sugar cane and sugar beets.—Although unrelated in culture, the common purpose of growing sugar beets and sugar cane permits their combination in a statement that their united value this year is estimated to be in the neighborhood of $50,000,000. This is a farm value for the raw material from which sugar, sirup, molasses, and feeding stuffs are derived in processes of manufacture.

Rice.—The rice crop is not as valuable as some other crops which are not mentioned here, yet its remarkable position entitles it to notice. Its production increased from 250,000,000 pounds of rough rice in 1899 to 517,000,000 pounds in 1903 and to 928,000,000 pounds in 1904; but the extraordinary production of 1904 fell to 637,000,000 pounds this year, and, although second in quantity, this year's crop is probably worth more than the crop of 1904, which was valued at $13,892,000.

Exceptional general level.—While it may be observed that only one crop—corn—reached its highest production this year, four crops reached their highest value—namely, corn, hay, wheat, and rice. The general level of production was high and that of prices still higher, so that no crops for which separate estimates can be made fall below third place in total value compared with the crops of preceding years, except potatoes, barley, tobacco, rye, and buckwheat. The cereals, including rice, more than maintained their previous strong position in production, and their aggregate yield is 4,521,000,000 bushels, with a farm value of $2,123,000,000, or $145,000,000 over last year.

DAIRY AND POULTRY PRODUCTS.

Butter and milk.—Both butter and milk have higher prices in 1905 than in 1904, and these, combined with increased production, permit an estimate of the value of dairy products at $665,000,000, or

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$54,000,000 above the estimate for last year. No crop but corn produces the income that the dairy cow does.

The farmer's hen is becoming a worthy companion to his cow. The annual production of eggs is now a score of billions, and, after supplying the needs of factories, tanneries, bakeries, and other trades, they are becoming a substitute for high-priced meats, besides entering more generally into the everyday food of the people. Poultry products have now climbed to a place of more than half a billion dollars in value; and so the farmer's hen competes with wheat for precedence.

TOTAL WEALTH PRODUCTION ON FARMS.

Dreams of wealth production could hardly equal the preceding figures into which various items of the farmer's industry have been translated; and yet the story is not done. When other items, which can not find place here, are included, it appears that the wealth production on farms in 1905 reached the highest amount ever attained by the farmer of this or any other country, a stupendous aggregate of results of brain and muscle and machine, amounting in value to $6,415,000,000.

The deduction from wealth produced, made in the report of last year on account of products fed to live stock, is not continued this year because the duplication of produced wealth in the consumption of products by farm animals is much less than has been assumed and is undoubtedly more than offset by the amount of wealth produced on farms which can not be estimated or even ascertained practically by census enumerators.

It might reasonably have been supposed in 1904 that the wealth produced by farmers had reached a value which would not be equaled perhaps for some years to follow, and yet that value is exceeded by the value for this year by $256,000,000, just as the value for that year exceeded that for 1903 by $242,000,000.

The grand aggregate of wealth produced on farms in 1905 exceeds that of 1904 by 4 per cent; it is greater than that of 1903 by 8 per cent; and transcends the census figures for 1899 by 36 per cent, and this after a lapse of only six years.

If there is no relapse from this high position that the farmer now holds as a wealth producer, three years hence he may look back over the preceding decade, and, if he will add the annual figures of his wealth production, he will find that the farming element, or about 35 per cent of the population, has produced an amount of wealth within these ten years equal to one-half of the entire National wealth produced by the toil and composed of the surpluses and savings of three centuries.

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DOMESTIC ANIMALS.

Horses.—In the last annual estimate made by this Department of the number and value of domestic animals on farms, nearly a year ago, it appears that the farmers' horses had never before been so numerous nor in the aggregate so valuable. First threatened by the bicycle, and later by the electric trolley car and the automobile, neither one of these, nor all combined, have scared the farmers' horses into diminished numbers or lower prices. On the contrary, horses on farms last winter were worth $1,200,000,000, or nearly as much as the corn crop of this year, and their number was over 17,000,000. Mules also are steadily increasing, and are worth $252,000,000.

Cattle.—Milch cows also are advancing in numbers and have reached a total of 17,570,000, worth $482,000,000. Other cattle, however, have not participated in this advance, and in recent years have declined in number and total value so that last winter they numbered 43,669,000, worth $662,000,000.

Sheep and swine.—Sheep, too, are declining in number and in total value, but swine are holding their previous position of many years, the number being 47,321,000, valued at $283,255,000.

Aggregate increase.—In the aggregate, the value of farm animals of all sorts has increased a few million dollars within a year and has increased $249,000,000 since the census of 1900, or 9 per cent.

FEATURES OF FOREIGN TRADE.

Unparalleled agricultural surplus.—Out of the enormous productions of the farms of this country the wants of 83,000,000 people have been supplied, and there remains a surplus large enough to become a generous contribution to the other nations of the earth and unparalleled among them as a National agricultural surplus.

During the last fiscal year (ending June 30, 1905) the exported domestic farm products were valued at $827,000,000. This was $51,000,000 below the annual average of the five preceding years, although it was $132,000,000 above the average of the five years 1895–1899, and $157,000,000 above the average of 1890–1894.

There was a loss of $32,000,000 as compared with the exports of farm products for the fiscal year 1904. In accounting for this it is proper to notice that the decrease in the exports of grain and grain products, due to the short wheat crop, equaled $41,000,000. To this decrease is to be added a reduction of $5,000,000 in exports of packing-house products, and another of $5,000,000 in fruits, and various minor items.

On the other hand, however, there were increases of $9,350,000 in

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exports of cotton; $4,700,000 in oil cake and oil-cake meal; $4,000,000 in vegetable oils; $2,000,000 in rice, and various minor increases.

The relative position of farm products in domestic exports is a declining one on account of the gain in exports of manufactures, so that, while the exports of the former averaged 62.6 per cent of all domestic exports for the five years 1900–1904, the percentage for 1905 was only 55.4 per cent.

During the last sixteen years the domestic exports of farm products have amounted to $12,000,000,000, or $1,000,000,000 more than enough to buy all the railroads of the country at their commercial valuation, and this with a mere surplus for which there was no demand at home.

Imports mostly noncompetitive.—In the matter of imports of farm products the total of the last fiscal year was $554,000,000, or $125,000,000 more than the annual average of the preceding five years. Over 1904 the gain was $92,000,000, which is accounted for by large increases in the imports of silk, wool, hides and skins, coffee, sugar, and molasses, against which there were relatively small decreases in imports of feathers, rice, tea, and vegetables. The imports of farm products in 1905 were 49.6 per cent of all imports, as compared with 46.7 per cent during the preceding five years.

Apparent balance of trade.—While the farmer has been a producer and a trader, he has also been an international paymaster. In his foreign trade of 1905 he had a net balance in his favor amounting to $285,000,000; in the preceding five years this favorable balance averaged $461,000,000; during the five years 1895–1899 it averaged $338,000,000, and in the five years preceding that the average was $271,000,000.

During the sixteen years past the farmer has secured a balance of $5,635,000,000 to himself in his international bookkeeping, and out of this he has offset an adverse balance of $543,000,000 in the foreign trade in products other than agricultural, and turned over to the Nation from his account with other nations $5,092,000,000.

Foreign trade in forest products.—Notwithstanding the constant weakening of the National forest resources, the exports of forest products had been increasing for many years, but during the fiscal year 1905 their value was $63,000,000, which was a decline of $6,300,000 from the preceding year.

Imported forest products are either noncompetitive with those of the Nation or introduced from Canada because of insufficient domestic production. The imports of 1905 were valued at $92,000,000, an increase of $12,000,000 over the preceding year, mostly on account of increased imports of india rubber, but partly on account of increased imports of lumber and wood pulp from Canada.

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FARMERS' SUPPORT OF MANUFACTURING.

Not content with his other achievements, the farmer lends his strong shoulder to the support of the manufactures of the country by furnishing raw materials. Computations based upon census information disclose the fact that farm products, to some extent obtained from other countries, constitute 56.4 per cent of the total products, and 86.8 per cent of the total materials, of the industries utilizing agricultural products as materials, and these industries produce 36.3 per cent of all manufactured products and use 42 per cent of all materials employed in manufacturing.

At the same time these industries using agricultural materials employed 37.8 per cent of all persons engaged in manufacturing, and the capital of these industries is 42.1 per cent of the capital of all manufacturing establishments.

Restated in absolute terms, during the last census year the farm products employed in certain manufactures were valued at $2,679,000,000; the value of all materials, including the preceding amount, was $3,087,000,000; and the products of the industries using these materials were valued at $4,720,000,000. These industries employed 2,154,000 persons and had a capital of $4,132,000,000.

Such are the enormous interests, not engaged in agriculture, but in industries that could not maintain themselves without the farmer and his extraordinary productive ability.

FARMERS BECOMING BANKERS.

Naturally such a large class of the population as the farmers, producing wealth and surpluses to the extent that they are, have savings which they invest in various ways, since in this country the stocking and its hiding place are not the savings bank. One of the most notable outgrowths of savings by farmers is the very great multiplication of small national banks in recent years. Under the amendment to the national banking act, permitting the organization of banks with a capital of less than $50,000, as many as 1,754 of these banks were organized from March 14, 1900, to October 31, 1905, excluding those organized in the noncontiguous possessions. These banks are distributed mostly throughout the South and the North Central States in rural regions, where they depend for their business primarily and directly upon the farmers' prosperity and, secondarily, upon the village merchants and persons of other employment, who themselves are dependent upon the prosperity of the farmers.

In the Southern States 633 of these banks were organized, representing 36.1 per cent of the total number; in the North Central States the number was 792, or 45.2 per cent of the total. To one who is familiar with State and regional conditions it is significant to

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notice that in the North Central States west of the Mississippi River 513 of these banks were organized, representing 29.3 per cent of the total number, and that in the Southwestern region, embracing Texas, Indian Territory, and Oklahoma, 397 new small banks stand for 26.2 per cent of the total.

If the capital of these banks had been sent from Boston and New York it would have been such a proceeding as was common fifteen years ago; but, instead of coming from such an origin, the capital of these banks has come from the farmers. The State bank commissioner of Kansas, in his report for 1904, states that "it has been an era of small banks in isolated communities, and so many have been started that to-day every hamlet in the State where any considerable business is done has a bank. This increase in the number of small banks arises, first, from the fact that farmers and business men in these communities had idle money that they desired to invest and banking appealed to them," etc. The same cause for the establishment of these banks is reported from the South and North Central and Western groups of States.

DEPOSITORS IN BANKS.

In the North Central States farmers have been depositing money in the banks until the rate of interest on deposits has fallen so low that they have diverted a large portion of their savings to permanent investments. In spite of the fact that the banks do not receive and keep all or most of the farmers' savings, the increase of bank deposits in agricultural States and larger regions is most extraordinary. The following are some examples of the increase of the deposits in all banks in the agricultural States during the year ending June 30, 1905: In Iowa and South Dakota the increase was 14.9 per cent; in Nebraska, 13.5; in Kansas, 9.7; in North Dakota, 25. During the same time bank deposits in the great capital State of Massachusetts increased 9.1 per cent.

Still more remarkable is the bank statement for the South Central States. During the past year the deposits increased 18.1 per cent in Texas, 21.4 in Oklahoma, 24.1 per cent in Arkansas, and 45.7 per cent in the Indian Territory, while throughout the whole area of that geographic division the increase was 22.8 per cent. The general average increase for the United States was 13.5 per cent.

If a comparison is made with 1896, within the latest prolonged financial depression, the comparisons are still more striking. During the ten years from that year to June 30, 1905, the bank deposits of the United States, all banks included, increased 129.2 per cent. In comparison with this is the increase of the South Atlantic States, 167.4 per cent; of the Western or Rocky Mountain and Pacific States,

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169.8 per cent; of the North Central States, 185.5 per cent; and still more striking is the percentage of the South Central States, 255.7 per cent; while during the same time the deposits in the North Atlantic States increased only 102.3 per cent.

For individual States there are such increases during the ten years as 190.9 per cent for Iowa, 239.3 per cent for Kansas, 294 per cent for North Dakota, and 355.7 per cent for South Dakota. The progress of the South Central States was still more rapid, as evidenced in particular by Mississippi, with an increase of 347.1 per cent in bank deposits; by Texas, 248 per cent; by Oklahoma, 172.6 per cent; and by Arkansas, with 503.8 per cent.

For the first time in the financial history of the South, deposits in the banks of that region now exceed $1,000,000,000.

The foregoing remarkable increases in bank deposits in agricultural States, as well as the increase in the number of small country banks, are directly and indirectly because of the profits that have come to the farmers from the operation of their farms. The man with the hoe has become the man with the harvester and the depositor and shareholder of the bank.

DECADENCE OF THE CROP LIEN.

Nothing has been of greater financial moment to the cotton planters than the profitable price of cotton during the past three years. It has been the means of lifting them out of a rut that at times filled them with despair. The crop lien, which was a necessity immediately after the civil war, is disappearing where it has not already gone and released the planters from its bondage.

For the first time in nearly half a century the cotton planter's unsecured note is now good at the bank, and his land is a safe security and is salable.

INCREASE IN FARM VALUES.

Such an account of the farms of the United States as is given in the foregoing matter may seem too optimistic in tone and too extravagant in expression. With the expectation that the story of the year would present this appearance, and to verify or discredit it, the Department undertook and has just completed an investigation of the changes in the values per acre of medium farms since the census of 1900. The net result of these changes is an enormous increase in the values, which increase is entirely consonant with the period of high prosperity that the farmers have enjoyed since 1900, the only considerable blot upon an otherwise clean record of these years being the very deficient corn crop of 1901.

Inquiries were addressed to 45,000 correspondents, representing almost every agricultural neighborhood in the United States, and the

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returns of these correspondents warrant the statements that follow. The values asked for and reported include the buildings and all improvements, but no personal property.

Percentage of gain.—During the five years last past the value of the real estate of medium farms of this country has increased 33.5 per cent, as compared with the census increase of 25 per cent for the real estate of all farms from 1890 to 1900. The highest percentage of increase—40.3 per cent—is found in the South Central group of States. Next to this is 40.2 for the Western group, which includes the Rocky Mountain and Pacific States. Third in order is the South Atlantic group, with 36 per cent of increase. The North Central States, containing most of the great cereal and live-stock surplus region, increased 35.3 per cent, and lowest of all was the increase of the North Atlantic States—13.5 per cent. Thus it appears that the medium farms of the South have increased in value in a greater degree than the medium farms of the entire North as far west as the Rocky Mountains.

Farms are classified according to their principal sources of income, conforming substantially to the census classification for 1900. With this understanding, correspondents report an increase of 48.2 per cent in value per acre for the medium cotton farms during the five years, 35 per cent for the hay and grain farms, 34.3 per cent for the live-stock farms, and 33.2 per cent for the farms devoted principally to sugar cane and sugar beets. Rice farming follows with an increase of 32.2 per cent in value per acre, while close to this is 32.1 per cent for tobacco farms. Next in order are the farms devoted to general farming, with an increase of value per acre amounting to 30.1 per cent, after which are the fruit farms, with an increase of 27.9 per cent; vegetable farms, 26.7 per cent; and, lowest of all, the dairy farms. with an increase of 25.8 per cent.

Dollars of gain per acre.—When a comparison is made among the various regions of the country and among the various classes of farms with regard to the number of dollars of increase, rather than the percentage of increase, the results are very different from the preceding. The medium farms of the North Central division increased on the average $11.25 per acre during the five years. In the Western division of States the increase was $5.33; in the North Atlantic States, $5.26; while the increases were lowest in the South, where in the South Atlantic division the gain was $4.93, and in the South Central, $4.66. The average increase per acre of medium farms in the United States, all classes combined, was $7.31.

Although the rate of increase for cotton farms was highest of all specialized farms, the amount of increase per acre was lowest, or $5.21 Next above this is rice, with $5.97; live stock, with $6.40; and general

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farming, $6.78. Rising considerably above this was the increase for dairy farms, $8.53; tobacco farms, $9.13; and hay and grain farms, $9.43. The highest increases are for vegetable farms, $11.10; sugar farms, $12.34; and fruit farms, $15.29.

Causes of increase.—While some decreased values were found in a few places, due to local causes, the general fact of large increases in farm values was explained by correspondents with much particularity. The increase is chiefly due to better prices and more profitable results of farm operations, leading to a higher capitalization of land on account of increased net profit. But this by no means fully accounts for the marked increase discovered in farm values, when secondary causes are considered. Everywhere is revealed a more intelligent agriculture; the farmers are improving their cultural methods and are changing from less profitable to more profitable crops. They are discovering that high cost of production attends extensive agriculture, and that, on the contrary, intensive culture and intensive crops increase the net profits per acre. As disclosed in the preceding increases of average acre values, the farms of the less intensive culture and crop have increased in value less than the farms having the more valuable crops receiving high culture.

Other causes for higher values are the erection of new buildings, the keeping of buildings in better repair, better fences, tile draining of land that has been too wet, and a general improvement in farm thrift. New facilities for transportation, where existing, are everywhere reported as at once raising the value of farm lands, whether new railroads or wagon roads that will permit the hauling of larger loads and for longer distances.

Another cause of increase which has had a distinct effect by itself is the growing desire and ability of farmers, and townspeople also, to invest in farm lands as affording a safe investment, even though the rate of interest, as values now are, is not high.

Many minor causes have cooperated with the foregoing to bring about the wonderful increase in farm values during the past five years that the Department has discovered.

Grand aggregate increase of value.—The correspondents reporting with regard to this matter were requested to state increases and decreases for medium farms. There are reasons for believing that the increases for this class of farms may be extended to farms below and above the medium without a material distortion of the fact as representing all farms. While the increases reported for medium farms are higher than for the more poorly kept and less productive farms, on the other hand they are lower than for the better kept and more productive farms of the highest class, which are not covered in the reports of correspondents.

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Accepting, then, the increased average acre values of the various classes of medium specialized and general farms as applicable to all farms, including those above and below medium, with such pertinent qualifications as may be made, these increases are applied to the total number of farms of the various classes with results which, it is believed, are approximately correct.

With this understanding it is found that the cotton farms have increased in value $460,000,000, the most prominent increase among the States being Texas, with $115,000,000, while Georgia stands second with $77,000,000, and Mississippi third with $62,000,000. Therefore, it may be said that during the last five years the cotton plantations have had six crops of cotton, one of these crops being a permanent investment and promising to pay a good return year by year.

Sugar farms have increased in value $20,000,000, more than half of which is found in Louisiana and one-sixth in California.

Hay and grain farms have such an immense acreage that the increase for them amounts to $2,000,000,000, three-fourths of which is in the North Central States; and an even greater gain, or $2,263,000,000, was made by the live-stock farms, nearly three-fourths of this also being in the North Central States. In the case of farms having dairying as a specialty the increased value was $369,000,000; tobacco farms increased $57,000,000; rice farms, $3,300,000; fruit, $94,000,000; vegetable farms, $113,000,000; and farms devoted to general and miscellaneous purposes, $768,000,000.

In the grand aggregate of all farms of all classes the increased value equaled the enormous total of $6,131,000,000.

Every sunset during the past five years has registered an increase of $3,400,000 in the value of the farms of this country; every month has piled this value upon value until it has reached $101,000,000; that portion of the National debt bearing interest is equaled by the increased value of farms in nine months, and this increase for a little over a year balances the entire interest and noninterest bearing debt of the United States.

This increased value that has come to farms is invested better than in bank deposits or even in the gilt-edged bonds of private corporations.

ECONOMIC POSITION OF FARMERS.

If the farmers' economic position in the United States is to be condensed to a short paragraph, it may be said that their farms produced this year wealth valued at $6,415,000,000; that farm products are yearly exported with a port value of $875,000,000; that farmers have reversed an adverse international balance of trade, and have been building up one favorable to this country by sending to foreign nations a surplus which in sixteen years has aggregated $12,000,000,000, leaving an apparent net balance of trade during that

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time amounting to $5,092,000,000 after an adverse balance against manufactures and other products not agricultural, amounting to $543,000,000, has been offset. The manufacturing industries that depend upon farm products for raw materials employed 2,154,000 persons in 1900 and used a capital of $4,132,000,000. Within a decade farmers have become prominent as bankers and as money lenders throughout large areas; and during the past five years prosperous conditions and the better-directed efforts of the farmers themselves have increased the value of their farms 33.5 per cent, or an amount approximately equal to $6,131,000,000.

In presenting this the first Annual Report of the third term of the present incumbent of the office of Secretary of Agriculture it has seemed desirable to deviate somewhat from the usual character of this document. As a rule, these reports cover the operations of the Department for a single year, and give considerable space to recording instances of new work undertaken and of partial progress made in the work being carried on. The principal purpose of the present report is to review the work of the Department during the past eight years, and to present for consideration work not only begun but actually accomplished during that period on behalf of the farmer.

WEATHER BUREAU.

SUMMARY OF ACHIEVEMENTS.

The results accomplished by the Weather Bureau for the benefit of the farmer, the mariner, the shipper, the manufacturer, and the seeker after health or pleasure prove that there is no weather service anywhere in the world comparable with it. In recent years it has been equipped with standard instruments, apparatus, and furnishings of the latest design; daily maps are printed at nearly 100 of its local stations; large glass maps, containing the current weather reports, are exhibited each morning before important commercial associations; maps, printed or milleographed, are distributed within three hours from the time that the observations are made. Climatic statistics for the various States are collected from nearly 4,000 voluntary observers using standard instruments, and printed in the form of monthly State bulletins, so that the climate of one region can be readily compared with that of another. It has extended its network of stations around the Caribbean Sea and the Gulf of Mexico, so that no destructive tropical storm may come without warning. It has established stations in Bermuda and in the Bahamas, and arranged for cable cooperation in the Azores and along the western coast of Europe, which enables it to make forecasts for two or three days in advance for steamers leaving this country, and to warn steamers leaving Europe for America of severe storms which they

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may encounter on their western voyage. With kites and mountain stations it has explored the upper air and gained useful knowledge. It has conducted experiments in wireless, or space, telegraphy, and developed one of the best wireless systems now in use. It has extended its system of telegraphic and climatic observations, so that now, except in some portions of the Rocky Mountain States, the temperature and rainfall conditions of nearly every county can be ascertained. These observations are of great value in the development of the arid and subarid regions, especially in the organization of the extensive irrigation works recently authorized by Congress.

The average per annum increase in the cost of the weather service during the past ten years is 4.41 per cent. During the same period the daily distribution of forecasts and warnings, or of printed charts containing the daily meteorological data of the United States, has increased from 22,582 to 622,880 copies, of which 158,000 represent printed reports.

DISCIPLINE.

There is no part of the Government service in which rigid discipline is more necessary to its well being than in the United States Weather Bureau, which has to do with the saving of life and property. While its observations are made with scientific precision, yet its warnings of danger from floods, gales, or frigid air are the results of experience rather than mathematical reasoning; and, therefore, even with the maintenance of the highest forms of the merit system of appointment, promotion, and preferment, there will still be a small percentage of error in its warnings.

The Weather Bureau has developed and put into effect a fair, yet rigid, discipline for the control of its personnel—a system of merit in which each person works out his own status to such an extent that it is practically impossible for an incompetent or undeserving person to reach any important post of duty. With this discipline there is associated a system of study and examination which develops the intellectuality of those who receive advancement. Aided by such a discipline it has, with rare exceptions, given timely warning of the coming of injurious changes in temperature, and allowed no important storms or floods to come unannounced.

INCREASE OF SCIENTIFIC RESEARCH.

The present appropriation for the support of the Bureau is $1,392,990. This is the amount to be expended during the current fiscal year in applying the inexact science of meteorology to the commerce and the industries of the United States, and to the saving of human life. A knowledge of the coming weather enters so intimately into every contemplated human action that the question is often asked:

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What are the prospects for further improvement in the accuracy of weather forecasts, and can the seasons ever be foretold? The answer is that the Government has a corps of forecasters, the members of which are the survivals of the fittest in a thorough system of elimination by competition. Since they are now applying all of the knowledge of the atmosphere that has been revealed, little hope for material improvement in their work can be held out until a substantial addition is made to the pure science of the problem. This can only come through experimentation, study, and research. With 200 stations engaged in applying the science, it is a wise economy to devote at least one of them to the work of adding to the knowledge that we are annually spending nearly a million and a half of dollars to apply. Accordingly, we have endeavored to lay out a plan of study and research leading to an increase in our knowledge of the laws governing the atmosphere such as should eventually make it possible to add to the accuracy of weather forecasts and to make them for a longer period in advance.

The last thirty years has witnessed such remarkable progress in new branches of science that fields of research formerly closed to the meteorologist are now open to him and must not be neglected. Recent observations have led to the discovery of a possibly large variation in the amount of heat that is received from the sun or an equivalent possible variation in the transparency of the highest portions of the earth's atmosphere.

In such studies the Weather Bureau has hitherto taken a subordinate part, whereas in so-called practical meteorology it has always occupied the leading position.

The highest efficiency in any art requires a perfect knowledge of the higher science behind it. To establish law is necessarily antecedent to correct forecasts of rains, frosts, or storms.

MOUNT WEATHER RESEARCH OBSERVATORY.

Under the authority of Congress, three years ago, the Department undertook the establishment of a station at Mount Weather, Virginia, devoted to meteorological research, and has established there a plant especially adapted to atmospheric research. The temperature, moisture, and movements of the air at great heights will be ascertained by means of balloons and kites; the absorption of solar heat by the atmosphere will be measured; the dissipation of solar light and heat will be determined; the special analysis of the sunbeam will be carried out, and the electric condition will be determined. In addition to this we have added apparatus for studying the relations to the atmosphere of the magnetism of the earth, the temperature of the soil, and even the motions of the earth. All these phenomena have

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been shown to have a more or less intimate connection with meteorology.

In so far as aerial research may require it, sounding balloons will be liberated from many of the weather stations in distant parts of the country in cooperation with those at Mount Weather, since it is considered very important to know the condition of the atmosphere above the land every day of the year up to the greatest attainable height, especially during the passage of storms and cold waves. Therefore, Mount Weather may be expected to do as much for the science of meteorology and the future improvement of the service as the service has already done during the past thirty-five years for the material interests of the United States. The employees at this station must necessarily live close by their apparatus, and provision must be made for all the ordinary needs of domestic life precisely as is done in all large astronomical observatories and in military establishments. This has been done economically and in accordance with established usage.

RIVER AND FLOOD SERVICE.

Neither the year 1904–5 nor its immediate predecessor was productive of serious floods in the larger rivers, although several damaging floods occurred in the smaller rivers, notably in the upper Sacramento in January, 1905; in the Purgatory and upper Arkansas rivers of Colorado; the Rio Grande, Pecos, and upper Canadian rivers during the latter part of September and the early part of October, 1904; and in the Grand River of Michigan in June, 1905. The floods in the rivers of the southwest in September and October, 1904, were peculiar in that they occurred in the semiarid region and at a time of the year when heavy rainfall is not anticipated. Their coming was not announced, since no flood service had yet been organized in that part of the country. The damage done by the floods in Colorado, New Mexico, Oklahoma and Indian Territories, and Texas amounted to at least $4,000,000, of which the greatest share fell upon the railroads. The loss to the inhabitants was not less than $1,000,000. These very destructive floods brought to the attention of the Weather Bureau the need of a flood service in the States mentioned. Such a service has therefore been organized, with 15 river and 10 rainfall stations, the headquarters of the district being at Denver. Although the service is not complete, it has done much good in giving warning of the floods in the Rio Grande during May and June, 1905.

The flood of June, 1905, in the Grand River of Michigan, while not as great as that of 1904, was nevertheless a disastrous one, and that it was not even more so was without question due to the forecast and warning service given by the Weather Bureau.

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METEOROLOGY IN SCHOOLS.

The Weather Bureau has encouraged the study of meteorology in educational institutions by allowing its scientists, outside of their official duties, to deliver courses of lectures to students, so that there are now 20 institutions of learning where meteorology forms a part of the curriculum, thereby giving preliminary training to young men who, in after years, may succeed to the duties now performed by the meteorologists of the Government.

At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. In this way a general knowledge of the work of the Bureau is being disseminated in the community. During the past year several hundred such lectures have been given.

BUREAU OF ANIMAL INDUSTRY.

The work of the Bureau of Animal Industry is of great value to the country, and no part of it is of greater importance than the study and investigation of contagious animal diseases with a view to their prevention or control. In the war waged in the interest of stock raisers against contagious diseases the work of the Bureau of Animal Industry has been unremittingly carried on.

BLACKLEG.

In 1897 was begun an investigation for the immediate control of blackleg, or symptomatic anthrax. Losses from this disease were found to be very heavy in Texas, Indian Territory, Oklahoma, Kansas, Nebraska, Colorado, the Dakotas, and it was more or less prevalent in many other States. A series of experiments was made to determine the effect of vaccines, which were finally successful in developing a vaccine efficacious in producing immunity by a single vaccination. The preparation and distribution of this vaccine, with circulars giving methods for using it and containing a full account of the cause and nature of the disease, were undertaken on a large scale. Beginning with 355,000 doses distributed in 1898, the annual distribution was increased until it amounted to nearly 1,750,000 in 1903, with a little reduction since then, the distribution in 1905 amounting to 1,400,000. The effect has been to reduce losses from this disease from 10 to 12 per cent to about one-half of 1 per cent, and recent reports show that the dread disease is rapidly disappearing.

SWINE DISEASES.

In 1897 experiments were made looking to the control of infectious diseases of swine by administering a serum from animals inoculated,

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respectively, with the hog-cholera and the swine-plague germs. As a result of these experiments and the stamping-out work undertaken in July of that year, 49 entire herds, aggregating 2,904 animals, had been destroyed and the pens disinfected by the end of the year. This work demonstrated that the losses might be promptly checked by the stamping-out method, but many farmers objected to these measures being carried out, and it was difficult so to enforce the regulations as to prevent the spread of the disease from farm to farm. Continued experiments with the serum treatment showed that there were cases known as hog cholera which did not yield to the treatment, and the very careful work of the Biochemic Division of the Bureau extending over several years has proved that acute hog cholera is caused by a virus which has not yet been cultivated and identified, but which passes through filters which will entirely remove both the hog-cholera and the swine-plague bacilli. The discovery of this hitherto unsuspected contagion has opened up an entirely new field of investigation, which is being energetically developed, and experiments are under progress which, it is hoped, will throw some light upon methods of prevention adapted to this disease.

TEXAS FEVER.

Investigations have been conducted to throw further light upon the microbe organism which causes the Texas fever. It was found that this organism was fostered in the blood of southern animals for as long, in certain cases, as twelve years or more after the removal of the animals from infected districts. It was found, however, that the animal retains its immunity three years after the disappearance of the microbe organism from its blood.

Another point of interest was to determine whether Texas fever ticks were capable of transmitting the disease to susceptible cattle at any time or only when they had recently absorbed blood of cattle from infected districts. It has been found possible to develop ticks in which the power of producing disease is absent. These ticks do not necessarily carry the Texas fever contagion, but obtain the germs of the disease from infected cattle. Other interesting experiments are now being conducted in connection with the subject with a view to acquiring a knowledge which will enable the Department to render more and more efficacious its control of this disease.

SHEEP SCAB.

Sheep scab has been one of the greatest obstacles to successful sheep raising, and the Department has experienced a great deal of difficulty in fighting it. Even after the order of June 18, 1897, was issued diseased sheep continued to arrive in large numbers at the principal markets. In 1898 a bulletin, entitled "Sheep Scab: Its

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Nature and Treatment," was issued, giving full information upon this subject and specifying the treatment by which the disease might be eradicated. This bulletin had remarkable influence in educating sheep raisers in checking the disease and in informing the public as to a possibility of curing infected animals. In July, 1899, an important order was issued describing the manner in which affected sheep should be dipped, instead of leaving this to the discretion of the owners and commission merchants. This order approved of the tobacco-and-sulphur and the lime-and-sulphur dips; formulas were given for their preparation, and the animals had to be dipped in one or the other before they were allowed shipment in interstate commerce.

While this action of the Department specifying dips to be used has been much criticised, it has proved a most important step toward the eradication of sheep scab. The number of sheep dipped under official supervision in 1899 was 672,944. The number increased after the year 1900 by leaps and bounds, nearly 17,000,000 having been dipped in 1905. At the same time it has been found that the dips become more and more efficacious. Reliable returns received in regard to 6,000,000 sheep in 1904 showed an effective percentage of 99.35. It is doubtful if such a measure of success has been achieved in any other country in treating animals for this disease. As the result of this work, sheep scab has almost or quite disappeared from several States that were badly infected and is much less prevalent in most others. By continuing the work and slightly increasing the number of inspectors for a few years it can undoubtedly be eradicated.

MALADIE DU COÏT.

An outbreak of *maladie du coït*, a venereal disease of horses, was discovered in Nebraska in 1898. The disease is a dangerous and insidious one, many of the affected animals showing but very slight symptoms, and yet being capable of transmitting it. While, therefore, in the earlier stages apparently mild, it may be very serious and even fatal, and its existence threatens the horse industry in any section where it gains a foothold. It was important to undertake the suppression of the disease promptly to prevent at any cost its spread to other sections of the country. In 1901 twelve diseased animals were destroyed.

The semiwild condition of the country through which the disease had spread and the prejudices of the horse owners and their lack of cooperation made it a difficult matter to discover diseased animals. Yet in 1902 there were 95 diseased animals slaughtered and 29 diseased stallions castrated. In 1903 there were 16,287 horses inspected, 511 diseased animals slaughtered, 277 suspected animals quarantined,

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and 1,889 stallions castrated. An order was issued June 20, 1903, prohibiting the transportation of horses from the infected districts unless first inspected by an inspector of the Bureau, and the measures adopted in 1903 continued throughout 1904 and 1905, over 9,000 being inspected in the latter year without finding any actually diseased; also 23 suspected animals were slaughtered, and 9 stallions castrated. It appears from the investigations of the last year that the disease has been practically eradicated.

CATTLE MANGE.

The animals affected by mange were frequently found in important central markets, and accordingly a regulation was issued in June, 1903, prohibiting the shipment from one State to another of affected cattle, and making regulations for the inspection and certification of cattle from the infected districts, and the cleaning and disinfecting of cars. The number of cattle inspected under this order in 1904 was 1,124,321, and the number of dippings exceeded 157,000, and 535 infected cars were disinfected. The number of horses inspected for mange was 752; 453 were found diseased, and 138 were dipped. In 1905 the number of inspections of cattle was over 14,000,000, the number of dippings 563,394, and 29,897 cars were cleaned and disinfected. There were also inspected for mange 15,971 horses.

FOOT-AND-MOUTH DISEASE.

In the fall of 1902 there occurred an outbreak in New England of the foot-and-mouth disease, and arrangements were at once made with the authorities of the affected States—Massachusetts, Rhode Island, and Vermont—for the eradication of the disease. About 3,000 animals were known to be affected in December; the infected animals were placed under quarantine, a carefully selected force of inspectors organized, and arrangements were made for slaughtering the diseased herds and disinfecting the premises. Owing to the extreme cold and hard freeze, the work of disposing of the carcasses and disinfecting the premises was very difficult. In spite of this, the work was pushed energetically and the spread of the disease was promptly checked. In all, 244 herds, containing 4,712 cattle, were affected; 3,872 cattle were slaughtered, besides a number of hogs, sheep, and goats which had been exposed.

Over $128,000 was paid in compensation for these animals. In the meantime the disease had spread somewhat extensively into New Hampshire, and thorough investigation was made of a considerable part of that State. It was found possible to remove the quarantine May 9, 1903, from Rhode Island, while the port of Boston, which had been closed to the exportation of animals during the outbreak, was reopened July 20, 1903, the quarantine of animals in Massachusetts

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being removed the following October. It would be impossible to commend too highly the fidelity and energy with which the force of the Bureau carried on the work of eradication in spite of many difficulties. This campaign against a contagious animal disease stands unrivaled, if we consider the celerity, the economy, and the satisfactory results of the work.

TUBERCULOSIS.

Tuberculosis has been studied both as to its effects upon the animal industry of the country and as to the danger of its being communicated from animals to man. It is not uncommon to find herds of dairy cattle where 50 to 90 per cent of the animals are affected with this disease, and in our meat-inspection service there have been found in some large abattoirs nearly 3 per cent of hogs with tuberculosis. The disease, therefore, deserves the most careful study. The studies of the Bureau have been much helped by certain discoveries made by our own employees by which methods of investigation have been greatly improved. Experiments with monkeys showed that these animals are susceptible to both forms of the disease—bovine and human—and that there is little difference to be seen in the results of the infection with either. Careful observations soon indicated that with cattle the disease is more frequently contracted by taking in the bacilli with the inspired air than with the ingested food. A study was made of a herd of 102 cows, 76 of which showed reaction to the tuberculin test, to determine the infectiveness of milk from cows that had reacted to the test. As a result of this study the following conclusions were reached:

(1) The tubercle bacillus may be demonstrated in milk from tuberculous cows when the udders show no perceptible evidence of disease, either macroscopically or microscopically.

(2) The bacillus of tuberculosis may be excreted from such an udder in sufficient numbers to produce infection in experimental animals both by ingestion and inoculation.

(3) In cows suffering from tuberculosis the udder may, therefore, become affected at any moment.

(4) The presence of the tubercle bacillus in the milk of tuberculous cows is not constant, but varies from day to day.

(5) Cows secreting virulent milk may be affected with tuberculosis to a degree that can be detected only by the tuberculin test.

(6) The physical examination or general appearance of the animal can not foretell the infectiveness of the milk.

(7) The milk of all cows which have reacted to the tuberculin test should be considered as suspicious, and should be subjected to sterilization before using.

(8) Still better, tuberculous cows should not be used for general dairy purposes.

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In a paper entitled "Danger of Infection with Tuberculosis by Different Kinds of Exposure," which gives the results of long and careful study of the subject, the following conclusions are presented:

The tendency of the results obtained from our experiments is to point to the conclusion that the presence of tubercular cows in a dairy herd is a danger which affects not only the health of the persons who use the milk, but also the prosperity of the owner of the cattle, and consequently that it is necessary, both for moral and economical reasons, that our dairy herds should be made free from tubercular animals as soon as possible. * * *

Too much stress can not be laid on the fact that tubercle bacilli are apparently more numerous in the environment of tubercular cattle than in their secretions from organs, like the udder, which have not become involved in the disease. Irrespective of the view that may be taken relative to the elimination of tubercle bacilli from the bodies of tubercular animals in their secretions from unaffected organs, it must be admitted that the chance for the introduction into these secretions, or into the secretions of healthy animals in the same environment, of infected material, such as particles of soiled forage or bedding, dust, masses of mucus which have adhered to the skin and hair, etc., is a very great danger, decidedly of too much importance to be ignored.

SURRA.

In 1901 a serious disease known as surra was found to exist among horses in the Philippines. Upon the request of the War Department for information on the subject an emergency report on this disease was at once prepared in the Bureau. There is reason to believe that the information thus made available has greatly assisted in the work of repression undertaken in those islands, besides aiding the inspectors of the Bureau in their efforts to keep out animals so infected. On account of this disease the Department has prohibited the landing of any animals from those islands at ports of the United States. Surra is very destructive in its effects on horses, and its introduction into the United States would be a great disaster.

TRICHINOSIS IN GERMANY.

In order to study this subject and to counteract statements continually made by the German press concerning American pork, an employee of the Bureau was sent to Berlin as an attaché of the American embassy to get a correct statement of available records bearing upon the subject. His report, published in 1901, is a clear exposition of the whole matter, and shows conclusively the harmlessness of the American pork shipped to Germany.

MEAT INSPECTION.

The subject of meat inspection grows in importance every year. It is not too much to assert that upon the success of this branch of our work depends a foreign trade worth many millions of dollars

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yearly to our stock raisers. The meat-inspection law provides for an ante-mortem and a post-mortem inspection. It has increased steadily from year to year. In 1898 the total number of animals inspected before slaughter aggregated over 51,000,000; over 9,000,000 of them being cattle, 10,000,000 sheep, and 31,000,000 hogs. In 1905 the total number inspected aggregated nearly 66,000,000. At the same time it is important and interesting to know that the increase in the number of animals rejected was much less proportionately than the increase in the number inspected.

In 1898 the number of animals inspected after slaughter was 31,000,000, of which over 4,000,000 were cattle, 5,500,000 sheep, and 21,000,000 hogs. The total number inspected after slaughter in 1905 was something over 40,000,000. There were tagged with the label of inspection in the year 1905 nearly 22,000,000 quarters of beef, nearly 8,000,000 carcasses of mutton, 845,000 carcasses of veal, 1,000,000 carcasses and 800,000 sacks of pork. Meat-inspection stamps indicating the regular post-morten inspection were affixed to 7,000,000 packages of beef in 1905, and to more than 15,000,000 packages of pork. The inspection of cars amounted in 1898 to 18,631, and in 1905 to 66,846. The number of live cattle inspected for export in 1905 was 824,914, of sheep 423,780, and of horses 2,358. In the same year 731 vessels which carried animals for export were inspected. The inspection of live animals at British ports by inspectors of the Bureau included in 1905, 401,623 cattle, 232,925 sheep, and 1,710 horses. Besides these inspections for our export trade, many thousands of inspections were made of imported animals.

NECESSITY OF ADEQUATE APPROPRIATION.

The importance of the cattle and meat inspection work of the Bureau of Animal Industry can not be exaggerated. It is only the certification, under the Government seal of the United States, as to the healthfulness of these products that enables us to place them in foreign markets. The withdrawal or even the restriction of our ability to supply such certification would mean the utter annihilation of our foreign trade in cattle and animal products. At the same time the Department is very much hampered by its inability to meet the demands for inspection for want of adequate appropriations. Requests for inspection—perfectly legitimate and having equal claims upon us with others already conceded—are constantly being received and continually increasing in number, so much so that even if the appropriations asked for for this Bureau last year had been allowed they would still have been inadequate to carry on the work. In the estimates submitted for next year these conditions are provided for, but it is only possible for the Department to carry on this important work adequately by the full compliance of Congress

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with the estimates submitted for this purpose. If an emergency appropriation be not allowed and made immediately available, the Department will be compelled to abandon a large part of this important work. I deem it impossible to emphasize this situation too strongly.

ANIMAL NUTRITION.

The construction of a respiration calorimeter at Middletown, Conn., by Professors Atwater and Rosa for the study of human nutrition in cooperation with the Department suggested similar work with animals. Work along this line was authorized in June, 1898, to be conducted by Dr. H. B. Armsby, of the Pennsylvania Experiment Station, and his assistants. The calorimeter was constructed on the plans of the Atwater-Rosa apparatus, specially adapted for use with animals. Experiments were made on the available energy of timothy hay; later, of clover hay and maize meal. The work is now in progress, concluding with a study of the influence of age and individuality on the nutrition of animals.

ANIMAL HUSBANDRY.

An expert in animal husbandry was appointed July 1, 1901, and his attention was chiefly devoted to the investigation of questions of animal husbandry and to the practical or economic side of stock raising. July 1, 1904, an appropriation of $25,000 became available for experiments in animal breeding and feeding in cooperation with the State stations, and this work was placed under the supervision of the expert in animal husbandry. Experiments have been begun in cooperation with the Colorado Experiment Station in breeding American carriage horses; with the Alabama Experiment Station in beef production; with the Maine Experiment Station in poultry breeding, and with the Maryland Experiment Station and the National Zoological Park in breeding zebra hybrids. A study has been begun on the fecundity of Poland China sows, with a view to determining whether sows of this breed have decreased in fecundity, and, if so, whether such decrease is chargeable to particular families. The effect of cotton seed and cotton-seed meal when fed to hogs is also under investigation. Several valuable publications on animal husbandry have already appeared.

ANGORA GOAT INDUSTRY.

The Bureau has aided the establishment of this industry in every way. The goats have been taken into every State and Territory, and reports of their success as mohair producers are numerous.

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THE MILCH GOAT INDUSTRY.

Careful investigation of milch goats of European countries have been made and the results printed in a bulletin. The demand for this publication has been large, very many physicians applying for it. During the past year an expert was sent to Europe to investigate the industry in the leading goat countries, and an importation was made of 59 does, 4 bucks, and 5 kids of the Maltese breed. These animals are being employed in cooperation with the experiment stations at Storrs, Conn., and College Park, Md. At the former place cheese making has been undertaken and milk will be supplied to tuberculous patients and to children's hospitals; at the latter, milk will be furnished in Washington, D. C., to be used in the treatment of various diseases.

THE DAIRY INDUSTRY.

Dairying constitutes one of the main branches of animal industry. This line of agricultural effort in the United States yields good returns to a great number of producers. A large amount of capital is invested in dairying, and the development of the industry has been marked by the intelligence and enterprise of those engaged therein.

The interests of this industry have been looked after by the Dairy Division of the Bureau of Animal Industry. This Division was organized June 30, 1895, and during the past eight years its work has steadily expanded in scope, amount, and importance. At first its efforts were limited to the collection and dissemination of information regarding the dairy industry. Statistics and general information were collected and published; and bulletins were prepared describing the principal breeds of dairy cattle and outlining the most approved methods employed in the several branches of the dairy industry in this country and in Europe.

As time passed and larger funds became available new studies and original investigations were taken up. These included studies and investigations relating to the conditions and demands of domestic and foreign markets; the production of milk and its distribution to the people of cities; imitations of and substitutes for dairy products; and the number and distribution of pure-bred dairy cattle and grades, with their effect upon production and results.

WORK RELATING TO MILK.

Milk, an important product in its new state, and the basis for the manufacture of all other dairy products, has naturally received the first and largest share of attention. Popular bulletins have been prepared and issued in large and repeated editions, the object of which has been to raise the standard of production by educating both the

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consumers and producers of milk. The most approved methods of feeding, handling, and milking dairy cows, and of cooling, handling, storing, and transporting milk have been presented, and the common errors and dangers involved in careless dairying forcibly pointed out.

WORK RELATING TO BUTTER.

The first work along this line consisted in a study, the results of which were reported in a paper entitled "Creameries or Butter Factories: Advantages, Location, Organization, and Equipment." The factory system of making butter was carefully investigated, and the methods of organizing, establishing, and conducting a creamery were outlined.

BUTTER EXPORTS.—Experimental exports of butter have received considerable attention. Special agents of the Department have visited Great Britain, France, Germany, China, Japan, and the Philippine Islands and arranged for experimental exports of butter to places in all. Trial shipments have been made to Germany, France, and England. The shipments to Manchester, England, have been most numerous and the most satisfactory, and a good reputation has been established for our butter in that quarter.

COLD STORAGE OF BUTTER.—To determine the best temperature at which to hold butter in storage, experiments were conducted in Chicago in 1903–4. The cream was collected and the butter made by the usual methods of a first-class creamery; the butter was put up in 60-pound tubs and stored at temperatures ranging from 5° F. below zero to 30° above zero. The results proved that a temperature a few degrees below zero is most desirable. The lot stored at 5° below kept almost perfectly for eight months, while the lots stored at 10° and 20° above zero deteriorated greatly.

RENOVATED BUTTER.—To the Dairy Division was assigned the duty of assisting in the administration of the act of Congress approved May 9, 1902, which authorized the Secretary of Agriculture to provide for inspecting the materials, factories, and processes employed in the manufacture of renovated butter, the object being to insure a sound and wholesome product and to see that renovated butter was labeled and marketed as such. This inspection work was assigned to nine inspectors located in commercial centers. The results have been very satisfactory. The character of the product of renovated-butter factories has been improved, and its price has become steadier; the total product of such factories has increased from 54,500,000 pounds in 1902–3 to 60,000,000 in 1904–5; and the law has not proven in any way detrimental to the makers of country butter, whose product forms the bulk of the stock worked up in such factories. In 1903–4 the inspectors of the Dairy Division reported inspections of 76 factories,

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and visited the markets in 274 cities located in 44 States and Territories, to investigate and correct the conditions under which the renovated product was marketed. All renovated butter exported is inspected and certified by the dairy inspectors.

WORK RELATING TO CHEESE.

COLD CURING OF CHEESE.—In 1902–3 experiments were carried on in cooperation with the State experiment stations of New York and Wisconsin in the cold curing of cheese. In these experiments about 5½ tons of cheese were used, including all types of American cheese. Cheeses were cured at three temperatures, 40°, 50°, and 60° F. The commercial quality of the cured cheese was tested by a jury of experts. The advantage of curing at low temperature was established. More recently an important experiment has been made in the cold storing of cheese, and the results were quite similar to those secured in the cold-curing experiment.

EXPERIMENT WITH SOFT CHEESE.—An interesting experiment now in progress in cooperation with the agricultural experiment station at Storrs, Conn., relates to the manufacture in this country of soft cheese of the Brie and Camembert types, so largely made in western Europe. About 1,000,000 pounds of this kind of cheese are imported into this country annually. The object of this experiment is to ascertain the principles involved in the manufacture and to instruct the American farmers in the art, so that they can make these cheeses on their own farms.

WORK RELATING TO DAIRY CATTLE.

Realizing that the dairyman's success is so largely dependent on the character of his herd, the Dairy Division has given much attention to dairy cattle and has issued several publications on the subject. The object has been to improve the dairy stock of the country, and two lines of effort promising the largest measure of improvement have been kept continually before those engaged in the industry—(1) the increase of pure-bred stock of recognized dairy breeds, and (2) selection and breeding to secure cows of dairy type.

MISCELLANEOUS WORK OF THE DAIRY DIVISION.

STUDIES OF DAIRYING.—Representatives of the Division have gone into various sections of the country to study conditions as they exist and to report upon the actual development of dairy industries. Such work has resulted in the issue of several publications.

DAIRY STATISTICS.—This subject has received continued attention. Recently a compilation of the principal statistics relating to the

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dairy industry in the United States was made and published, with maps and diagrams.

DAIRY LAWS AND ASSOCIATIONS.—A compilation of the laws of States and Territories relating to dairying, inspection, and adulteration of dairy products, etc., has been prepared and published. Circulars have also been issued annually giving a list of the officials and associations relating to dairying in the United States and Canada.

BUREAU OF PLANT INDUSTRY.

Plant investigations have been a feature of the Department's work since its establishment, although the organization of the Bureau of Plant Industry was not effected till July 1, 1901. It consists now of eleven offices, each of which is charged with the handling of a group of important plant problems. The work is carried on by 508 employees, about 60 per cent of whom are engaged in scientific work. The work of the Bureau is designed to bear directly on the practical questions which daily confront the tiller of the soil.

PROGRESS IN TREATING PLANT DISEASES.

Extensive investigations have been made in the treatment of plant diseases, with excellent results.

Peach-curl, a disease which occurs wherever the peach is grown, but is especially severe on the Pacific coast, has been brought under control. Experiments on the Pacific coast have resulted during one year alone in a saving of nearly a quarter of a million dollars' worth of fruit.

The little-peach disease, which at one time threatened the orchards of Michigan, New York, and other States, has been studied and its nature and method of control determined. The systematic destruction of the trees, under careful scientific inspection and regulations, is making possible rehabilitation of the peach fruit industry in a number of sections.

Pear blight has received special attention during the past six or eight years. Its nature has been thoroughly determined, and the methods of treatment recommended by the Department are now being followed by large pear growers in a number of parts of the country. Wherever the work of handling the disease is conducted systematically and scientifically, success has followed.

The Department has devoted special attention to the study of diseases of citrus fruits, recognizing the great value of this crop. A method of controlling wither-tip, orange blight, and sooty mold of citrus fruits has been developed and is now in actual use in a number of regions.

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The cranberry crop of this country is valued at about $2,000,000. Some years ago the crop was seriously threatened by a disease known as "scald." The Department's investigations resulted in the discovery of the cause of the disease and a method of prevention, thoroughly practicable, which is now in use.

Conservative estimates have placed the annual loss from bitter rot of apples in certain seasons, in the United States, at over $10,000,000. This disease has been successfully treated by spraying. In the past season 90 per cent of the fruit in large orchards was saved, while in adjacent orchards, not treated, the loss was nearly complete.

A number of important crops, such as cabbage, turnips, etc., have from year to year been seriously troubled by certain forms of bacterial diseases. These diseases have been studied, their natures determined, and in most cases remedies developed and put into practical use.

Some destructive diseases of the most important agricultural crops of the South, notably cotton, the cowpea, and the watermelon, have been studied and remedies found for them. One of the most serious diseases of cotton, which for years caused great loss, was wilt. This trouble was especially destructive in the Sea Island districts. Careful scientific investigations showed the cause of the disease to be a minute fungus working in the roots, and it was further shown that certain plants were able to resist this fungus. Selection of seed from year to year from these plants has resulted in the establishment of resistant types. At the same time that resistance was being developed it was necessary to maintain the value of the types in other directions, notably in lint production, length of fiber, etc. This has all been done.

Cowpeas, which are used extensively in rotation with cotton, are also subject to the same disease, and it therefore became necessary to secure resistant varieties of this crop. This has been accomplished.

The great importance of intensive horticultural work has been fully recognized by the Bureau of Plant Industry in the study of plant diseases. Plants grown under glass are necessarily subject to a number of serious troubles. The Bermuda lily, a very important crop, has for years been subject to a disease which investigations have shown is primarily due to improper methods of cultivation. Methods of avoiding these troubles have been developed by the Department, and in most cases the disease may now be successfully controlled.

Diseases of the violet, the calla lily, the carnation, and other crops have been studied, and important discoveries in reference to their causes and control have been announced.

One of the most important lines of investigation conducted by this Bureau during the past eight years, in cooperation with the Forest Service, has had to do with a study of the decay of construction

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timber and methods of preventing such decay. This work has resulted in improved methods of handling construction timbers and impregnating them with protective substances. Only recently a cheap and effective method of treating fence posts has been discovered.

Within the past few years a serious disease appearing in the rice fields of South Carolina has threatened a most important industry of the State. Investigations of this disease, made in cooperation with the South Carolina Experiment Station, have resulted in the discovery of the cause of the disease and a comparatively simple remedy therefor.

AGRICULTURAL EXPLORATIONS.

Systematic work in securing new plants and seeds from foreign countries for introduction into the United States was inaugurated in 1897. Remote parts of the world have been searched by agricultural explorers for new crops, and valuable additions to our agricultural productions have been made. The aim of our agricultural explorers has been to seek living seeds and plants in quantity for extensive trial throughout the country. Their explorations have included the desert regions of Asia and Africa, the sub-Arctic regions of Russia, Norway, and Sweden, the climatically east-American regions of China and Japan, the tropical regions of the Dutch East Indies, the Pacific islands and Central America, and the Australian, South American, and South African regions of the southern hemisphere.

Our explorers have brought back large numbers of useful plants, which have been distributed to carefully selected experimenters. Among these is a new alfalfa, more resistant to drought and alkali than our common species. This was introduced from Turkestan, and is proving successful in the West.

The largest collection of date-palm varieties in the world has been secured and established in the Colorado River region of California and Arizona, and numbers of these imported palms have already borne fruit of good quality, proving the possibilities of date culture in that region. The largest collection of mangoes in the world, comprising the best varieties known, has been gathered from different parts of the Tropics and is now being distributed in Florida, Porto Rico, and Hawaii.

Long-staple Egyptian cottons have been introduced and used in the production of new hybrid types. These hybrid types already promise considerable value.

The best malting barley in Europe, the Hanna, has proven remarkably successful in the barley-growing sections of the Pacific slope and will be thoroughly tested.

The hard-shelled almond of Spain, heretofore unknown to our growers, has been introduced successfully in California.

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Large shipments of the hardy timber bamboos from Japan have been introduced and planted in the Gulf States and in California.

The pistache, which is a promising dry-land nut for regions where the almond fails, has been introduced in large quantities, and arrangements for its propagation and dissemination in the Southwest have been made.

ACHIEVEMENTS IN COTTON BREEDING.

In the breeding and improvement of cotton the first experiments of the Department were begun in 1899. At this time little had been published regarding cotton breeding. Careful methods of breeding were devised and methods of judging cottons by score cards worked out, which have become standards for work in this field of investigation. The frequency of natural crossing in the field was studied, so that different varieties might be grown without risk of mixing and deterioration. The correlation of characters, the laws governing the splitting up of hybrids, the form of plant, and other important matters have been carefully studied. Reliable advice can now be given to cotton seed-growers and breeders.

A most important problem in the cotton industry is the securing of varieties as productive as the ordinary staple sorts but producing longer and better lint. This can be done by two distinctly different methods.

The first method is to secure hybrids of the long-staple Sea Island cotton with the standard short staples, with a view to obtaining new sorts which combine (1) improved length of staple with the large bolls, opening well, and (2) the productive character of plant of the short staple. Many thousands of such hybrids have been made and carefully tested in the course of the Department's experiments, and three new sorts have been secured which possess distinctly valuable characters and are believed to be worthy of general propagation. These have been carefully bred until they are now nearly as uniform in type as the standard varieties, but require to be carefully selected for one or two more generations before they are generally distributed to planters. One of these hybrids, which is a distinctly Upland type of plant and produces large round 5-locked bolls, has fine silky lint from 1½ to 1⅝ inches in length and a smooth black seed, so that it may be easily ginned on roller gins if desired. The fiber of this variety will rival the Egyptian and lower grades of Sea Island. The other two varieties are similar, but have lint averaging only about 1⅜ inches.

A second method of securing improved staple, which has given very striking results, is the straight selection of the standard short-staple varieties. It was found by careful examination of such varieties as Russell and Jones Improved, which are both excellent stand-

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ard sorts, that there was considerable variation in the length of lint produced by different plants. Careful selection experiments have been conducted with both of these varieties, and the average length of lint in the breeding stock of these two varieties has been increased from the ordinary 1 to 1⅛ inches until it is now from 1¼ to 1⅜ inches; meanwhile the plants have maintained their full productiveness and all other good characters. These varieties, now clearly distinct from the original stock, should be propagated and placed with growers as rapidly as possible. King cotton, which has been so extensively recommended for cultivation in boll-weevil districts, but which has been condemned because of its poor lint qualities, has also shown itself capable of great improvement in the same manner.

All varieties of cotton have been found to vary greatly in their productivity in the case of different individuals and different strains of the same variety. One strain of Pride of Georgia, which for several years has been selected for increased yield by a careful system of pedigree breeding, has shown marked improvement. A considerable quantity of this seed will be distributed to planters in the spring of 1906, and in 1907 a still higher grade of select seed of the same variety will be available.

In the boll-weevil infested area there is great demand for earlier varieties of big-boll types. The extensive experiments inaugurated in 1904 on this subject have not yet reached a stage where safe conclusions can be drawn, but preliminary experiments started the year preceding have given one very early strain, selected from a native Texas big-boll sort, which has proven very productive and is considerably earlier than the big-boll sorts with which it has been compared. A limited trial distribution of the seed of this variety will be made in the spring of 1906.

A large quantity of Egyptian cotton is imported into this country annually and used in our mills. It seemed probable that with our extensive cotton area some soil and climate could be found where this cotton could be successfully grown. Experiments were conducted in various parts of the country and careful manufacturing tests were made with the fiber. These experiments have shown conclusively that we can in many places produce an excellent quality of fiber, possessing all the characteristics of the best Egyptian-grown fiber. The yield in most places, however, has been so low that these cottons can not compete with the ordinary Uplands. If they are to succeed, more productive and earlier sorts will have to be bred, or the cultivation will have to be conducted in the extreme southern part of the cotton belt, where there is a very long growing season.

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MEETING THE RAVAGES OF THE COTTON BOLL WEEVIL.

As the spread of the cotton boll weevil extended north and east in Texas it became evident that there were problems connected with the invasion of this pest other than those purely entomological. The invasion of the weevil necessitated, in many cases, a complete revolution in agricultural practices. The Bureau of Plant Industry, in order to meet this exigency, has had for the past two years a corps of workers in the field carrying on important investigations in the matter of breeding new types of cotton better adapted to the conditions which have arisen since the invasion of the weevil. It has been conducting demonstration work to point out and emphasize the value of the discoveries which have been made by the Bureau of Entomology and other branches of the Department and to encourage diversification of crops. It has been searching the cotton regions of this and other countries in the hope of discovering types of cotton better suited to the new conditions in the invaded territory. In connection with this work some important discoveries have been made in the matter of types of cotton which have, through a long series of years, been able to adapt themselves to the presence of the weevil.

The most important work, however, in this connection, has been the field demonstration work which has had for its object the bringing home to the people themselves practical methods of tillage, cultivation, and planting to enable them to grow cotton despite the presence of the weevil. This general demonstration work has been pushed energetically in Texas and also extended into Louisiana in advance of the insect.

NEW CITRUS FRUITS PRODUCED BY THE DEPARTMENT.

The two great freezes of the winter of 1894 and 1895, which killed to the ground practically every orange and lemon tree in Florida except in the extreme southern part of the State, served to emphasize the great importance of securing hardy varieties of these fruits. Experiments were started by the Department, and the results which have been obtained are very valuable and encouraging. It has been shown that valuable hardy races can be produced by crossing the very hardy cold-resisting trifoliate orange with the different varieties of the ordinary sweet orange. Two of these hybrids which were found to produce valuable fruits were propagated, and in the spring of 1905 distributed broadcast to interested growers in South Carolina, Georgia, Alabama, Louisiana, southern Tennessee and Arkansas, eastern and southern Texas, and regions of low altitude in Arizona, New Mexico, Washington, and Oregon. These fruits, being different from any known group of citrus fruits, were named citranges, and the two

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varieties distributed were named, respectively, the "Rusk" and the "Willits."

The Rusk citrange is a beautiful, smooth, round fruit, with a reddish flush, being very similar in size and appearance to the tangerine. It makes a good citrangeade, similar to lemonade, and is especially valuable to use for culinary purposes. The Willits citrange is more like a lemon in appearance and quality; it is to be recommended for use in making citrangeade, pies, etc., and may be served on occasion in the place of lemons. Both the Rusk and the Willits citranges are nearly seedless.

Four other varieties of hardy oranges, or citranges, have been obtained, each possessing special features of merit. One of these produces a fruit so similar in size and appearance to the ordinary orange that it can only be distinguished by an expert. This fruit has been named the Morton. The Morton citrange produces an exceedingly juicy fruit, of fine texture, which is almost totally seedless. As in the case of the Rusk and Willits citranges, it makes a delightful citrangeade and can be used for culinary purposes. Trees of this variety will be distributed to growers in the spring of 1906.

Another variety, similar to the Morton in appearance, but differing in flavor and tree characters, is also believed to be valuable and will be propagated for distribution as soon as possible.

A special feature of these hybrids is their fine foliage characters, which adapt them to propagation as lawn trees and as hedge plants. Some of the hybrid oranges are far superior in general adaptability to the trifoliate oranges often grown for this purpose, having much denser and handsomer foliage, and being largely evergreen, retaining the greater part of their foliage throughout the winter. The Rusk and Willits citranges and the two varieties last mentioned, however, are hardly satisfactory to use for general hedge purposes, as they are nearly seedless and would require to be propagated by budding. Fortunately, two hybrids have been secured which have the desirable hedge characters and have thus far produced an abundance of seeds, indicating that they will be very desirable for use in this way. These two varieties will be tested as hedge plants and distributed if they continue to form numerous seeds, which will allow of their easy and cheap propagation.

In the course of the experiments two new tangerines have been produced, which have been named the "Weshart" and the "Trimble." These produce fruits considerably larger than the ordinary tangerine and are nearly two weeks earlier in season—two very desirable characters. These varieties have been propagated as rapidly as possible, and a limited distribution of budded trees will be made.

One of the most interesting of the Department's productions is the new tangelo. This fruit, a hybrid of the pomelo with the tangerine,

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may be described as a small, loose-skinned ("kid-glove") pomelo. It has a good sprightly acid flavor, which it is believed will render it a popular fruit. It has been named the "Sampson," and a limited distribution of stock will be made next spring.

One very excellent variety of sweet orange has been secured, which will probably be propagated and introduced. It is a large, round blood orange, nearly seedless.

Within recent years the lime has become an important commercial fruit, but as yet the trees grown are mainly seedlings and the fruits are very variable in shape, size, and quality. Some markets are coming to demand fruits of a certain size, and it is desirable that growers should plant varieties of known characters. Two new seedlings producing fruit uniform in size and of good quality have been secured in the Department's experiments; these will receive names and will be distributed in lime-growing regions. One of these produces a small fruit and the other a large fruit. In both cases the fruit is produced mainly near the exterior of the tree, which is a character of importance, as it greatly facilitates the harvesting.

NEW PINEAPPLES PRODUCED BY THE DEPARTMENT.

The so-called fancy varieties of pineapples grown and tested in the United States have as a whole proved unsatisfactory, so that their cultivation has been largely abandoned for the cultivation of the inferior but more robust and hardy varieties, such as the Red Spanish. It is thus desirable that varieties of better fruit qualities be secured, which at the same time will have a vigorous, hardy constitution, adapting them to general cultivation. To secure such improved sorts many hybrids have been made by the Department, the experiments having been started mainly in 1896 and 1897. These have as a whole produced fruits of exceptionally good quality. Many smooth, spineless-leaved sorts have also been produced, and as only one smooth-leaved sort is now cultivated in Florida some of these varieties will doubtless prove of considerable value. Five new varieties have been sufficiently tested to demonstrate their value, and these have been named and will be distributed to planters as soon as sufficient stock can be propagated. A number of other varieties of promise have been secured, some of which will doubtless prove to be of value.

WORK ON NITROGEN FIXATION.

The great value of leguminous crops for forage and as soil improvers, especially in their ability under certain conditions to fix atmospheric nitrogen, led this Department in 1899 to undertake a study of the Old World legumes with a view to introducing into the United States such as promised to be valuable in regions not now

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well supplied with these crops. Early in this work it became evident that we must also introduce the tubercle bacteria, especially for those species of legumes not having closely related species in cultivation in the United States. During the following three years a large number of introductions of these crops was made, and in all cases where it seemed desirable root samples containing tubercles were also secured. The isolation and distribution of these nodule-forming bacteria, with their appropriate crops, was believed to be one of the prime factors in their successful introduction. The common practice of inoculating leguminous crops by the use of soil which was known to contain the proper bacteria was not only expensive, especially where the soil had to be transported for long distances, but was fraught with great danger of introducing noxious weeds, plant diseases, and insects. An investigation was therefore made of the method proposed by Nobbe and Hiltner, of Germany, for inoculation by the use of pure cultures under the name of "nitragin." It was found that these cultures had been tested very carefully in this country and in Europe and had proven unsatisfactory.

In the course of the investigations, moreover, it was soon found that the pure-culture method, as then practiced, was a failure, owing to the fact that the bacteria were cultivated artificially on a substratum rich in nitrogen, thus obtaining all of the nitrogen they desired for growth direct from their food supply without depending upon the atmosphere for it. It was found that as soon as the nitrogen was removed and the bacteria were required to depend upon the atmosphere for their supply of nitrogen it was possible to secure strains of bacteria with greatly increased nitrogen-fixing power. It was further found that these bacteria thus secured could be dried on an absorbent medium like cotton, retaining their vitality undiminished.

Extensive tests of this method of culture and distribution were made in the laboratory and field during 1902 and 1903. These tests under careful scientific control were so successful and the method was simplified so greatly that it seemed desirable to give it a careful test in the hands of practical farmers. It was believed that a method to be of any value should be simple enough to be used by an intelligent farmer. As a result of a general distribution of cultures in the latter part of 1903 and in the spring of 1904, it is evident that the method of distribution perfected by the Department has great advantages over any other method of soil inoculation yet devised. While there is much yet to be done in determining the conditions under which the use of these tubercle-forming bacteria will give the most favorable results, it is evident that we have a very successful method of growing and distributing them and increasing their nitrogen-fixing powers. No new development of this kind can be successful in the hands of everybody. Failure may come from many causes.

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Usually these causes are easily determined and corrected. Sometimes they are obscure and must be carefully investigated in order to be determined. On the whole, however, the intelligent farmer is able to use the cultures under favorable conditions with success and profit.

WORK ON WATER CONTAMINATION.

In 1902, under authority from Congress, this Department began an investigation of algal and bacterial contaminations of water supplies. Some preliminary tests made in 1901 in removing algæ from cress beds were so successful that it seemed desirable to test the method under a wider range of conditions. Although sand filtration in the case of water supplies for domestic use had proved successful in removing bacterial contamination, it failed completely in the matter of algal organisms that give disagreeable tastes and odors to water in which the algæ occur. Extensive tests were made in the laboratory during 1902 and 1903, and also in large reservoirs and other water supplies in various parts of the country. The results of these tests were first published in May, 1904. In this report it was shown that minute traces of copper, so small as to be entirely harmless to man and to the higher animals (and even to fish, if properly used), would successfully destroy not only contaminating algæ but also bacteria of the typhoid and cholera groups. The method has been further tested in cooperation with boards of health and water engineers in many parts of the country during the past two years, and in nearly every case where the work has been done according to directions of the Department it has resulted successfully. Many intelligent boards of health and water engineers are recognizing the value of the method when used under proper conditions.

TOBACCO WORK.

A special feature has been made of tobacco investigations during the past eight years. One of the most important lines of investigation which was undertaken and completed was a study of the causes of fermentation in tobacco. Before this work was begun the underlying principles governing fermentation were not understood. In fact, the cause was not known, it being attributed by some investigators to living organisms and by others to various causes. A careful scientific physiological study of the subject resulted in the discovery that fermentation is due to the action of certain enzymes. In the light of this discovery it became practicable to make many new suggestions in regard to a better handling of tobacco.

Another important line of work has been a study of the types of tobacco, with a view to securing uniformity and the improvement of existing forms by breeding and selection. Large sums of money

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have been spent in attempts to introduce seed of foreign types of tobacco into this country and to grow these types in such a manner that the plants would be uniform, but with unsatisfactory results until the discovery was made that to secure uniformity in types, careful attention must be paid to the development of the seed, especially in the matter of the pollination of the flowers. This work has shown the practicability of developing in a few years uniform types of tobacco, which will make possible the growing in this country of types which are now largely imported, such as Sumatra, the Havana filler, and other forms. The work has furthermore shown the great possibilities of securing new types by crossing. The discovery of the means of fixing these types has greatly improved the prospects of the entire industry.

ADVANCES IN GRASS AND FORAGE PLANT INVESTIGATIONS.

The Department has made considerable progress in grass and forage plant investigations. Largely through its efforts, alfalfa has been thoroughly established in almost every State, including the Eastern States. The new Turkestan variety, introduced by our explorers, has proved to be of special value for the Northwest and other cold, dry sections.

Methods of restoring denuded ranges and maintaining a productive condition have been worked out. Several spineless varieties of cactus have been introduced from Mexico, the value of this plant as a forage crop having been demonstrated.

It has been found possible to control drifting sand by vegetation, and valuable results have been secured in covering railroad embankments and cuts with plant growth.

Cowpeas, soy beans, and new varieties of sorghum have all been effectively studied, and their growth extended. Several new varieties have been studied, and their value for hay and pasture demonstrated. A number of wild grasses have been introduced into cultivation. As a winter pasture and forage for the South the hairy vetch has assumed importance. A cheap and complete method of eradicating Johnson grass, which is probably the worst weed in the United States, has been worked out.

BETTER SEEDS FOR THE FARMER.

Methods and apparatus for testing seeds for mechanical purity and germination have been studied and perfected. By means of publications giving descriptions and drawings of weed seeds and the seed of our economic plants, farmers have been warned of the adulterants frequently found in field seeds and have been advised as to the general quality of those in the trade. They have been invited, in all cases

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of doubt, to submit samples to the Department for testing before buying.

Through samples of imported seed received from the custom-houses, information has been obtained as to the quality and kinds of seed being imported both for legitimate use and for purposes of adulteration.

The proper conditions for the storage of seeds under unfavorable climatic conditions have been determined. The handling of Kentucky bluegrass has been studied and the proper treatment to economically produce seed of high vitality has been pointed out.

IMPORTANT RESULTS IN GRAIN INVESTIGATIONS.

DURUM WHEAT.—Durum wheat was first introduced from east and south Russia in the spring of 1899. During the next year a much larger quantity of seed was imported, including varieties from North Africa. In 1901 there were produced probably 50,000 bushels of durum wheat. The following year there appear to have been grown considerably over 1,000,000 bushels. The production has steadily increased until in the season of 1905 it is conservatively estimated by grain dealers to be between twelve and fifteen million bushels for the three States of North Dakota, South Dakota, and Minnesota. Add to this about 5,000,000 bushels for Kansas, Nebraska, Colorado, and the Rocky Mountain and Pacific Coast States, and the result is a production of probably 20,000,000 bushels for the entire country.

Among many advantages claimed for this new crop are the following: It is well adapted to dry regions and to considerable areas where other kinds of wheat will not succeed. Even in those portions of the semiarid districts where other wheat can be grown the yield per acre of durum wheat exceeds that of the former by 30 to 100 per cent. Its average rust resistance is very much greater than that of common sorts. The experience of the semolina manufacturers of Europe is that the best macaroni can be made only from this kind of wheat. Durum wheat makes at least as good bread as any other wheat, and such bread is preferred by a large majority of consumers. Moreover, durum wheat bread remains fresh longer. The percentage of flour per bushel from durum wheat is greater than that produced from the best of other varieties and the sugar content of the bread much greater than that of bread from other flour.

It is reported that during October about 6,000,000 bushels of durum wheat were shipped to Europe and that the prices recently offered by importers were an advance of 12 cents over the price paid for the first shipments. The question of marketing the wheat, therefore, can no longer be a doubtful one, as our reputation for furnishing a good quality of grain is well established. As stated

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recently by an official of the board of trade of Duluth, durum wheat has "passed the experimental stage and is now a regular commodity."

SWEDISH SELECT OAT.—Another valuable new crop is a variety of oat known as "Swedish Select," introduced in the spring of 1899. This oat is a pedigreed variety, developed many years ago in Sweden and afterward thoroughly acclimated in the cold region of northern Russia. It is admirably adapted to our Northern States, and long ago became the most popular oat throughout the region from Wisconsin to Montana. The production has increased each year, and at least 4,000,000 bushels were grown this season. It is a vigorous white oat, weighs heavily, and is considerably resistant to drought. The yield per acre is generally better than that of any other variety tested in comparison in the Northern States.

SIXTY-DAY OAT.—This variety of oat was introduced from southwestern Russia four years ago, and is now giving results in the territory of the Middle West comparable to those obtained with the Swedish Select in the North. Being much earlier than ordinary oats, it is able to escape rust and other fungous and insect pests in seasons when other varieties are badly affected. For the same reason it also sometimes escapes the worst stage of a drought.

EXTENSION OF THE WINTER-GRAIN AREA.—One of the most important things in grain cultivation is to be able to grow fall-sown crops, as both the yield and quality of a winter grain are invariably better than those of spring grain in the same locality. A valuable achievement of the Department in this line is the successful introduction of winter barley, known as "Tennessee Winter," into northern latitudes. This barley is now thoroughly acclimated as far north as Kansas and gives yields so much greater than those of spring barleys and is so important on certain occasions for winter pasturage that it is causing little less than a revolution in grain cultivation in a number of localities.

Two Algerian barleys have been introduced with much success in the Southwest. They are thoroughly adapted to desert conditions and alkali soils and have so far given yields per acre that are from 50 to 80 per cent greater than those of other varieties in the region between Texas and southern California.

In the grain experiments carried on in cooperation with the Maryland Experiment Station it has been discovered that there are a number of important varieties of two-rowed hull-less and other kinds of barleys that are perfectly hardy when sown in the fall.

The winter-wheat area is being extended north and west, largely through the introduction of the Kharkof winter wheat, which has become almost as popular as the Swedish Select oat. It is closely allied to the well-known Kansas Turkey wheat, but is hardier both

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for the winter and in seasons of drought. The winter-wheat area has already been extended almost entirely over the State of Nebraska, to a considerable extent in Minnesota, and to a lesser extent in South Dakota.

OTHER CEREALS.—One of the most valuable cereals for feeding to sheep, hogs, and chickens is the Russian proso, or broom-corn millet. Several varieties of this cereal were introduced from Russia in 1899, at least two being more drought resistant and otherwise better adapted to the Northwestern States than any varieties of this millet heretofore grown in this country. It is particularly adapted for sheep feeding.

Better varieties of emmer (often called spelt) have also been established by the Department in the semiarid districts. This crop also resists drought to a great degree, and certain varieties resist rust as well. The winter variety is as hardy as the hardiest winter wheats. The emmer and proso together afford an immense amount of grain and straw for stock feeding in dry localities, where very little feed of any other kind can be produced.

ENCOURAGEMENT OF RICE PRODUCTION.

Rice has received special attention during the past six or seven years. The Japanese, or Kiushu, variety was brought into the country and disseminated. Since this introduction the development of the rice industry in the South has been phenomenal. Between 1899 and 1904 the rice acreage of Louisiana and Texas increased from 210,396 acres, yielding 179,919,293 pounds of rough rice, in 1899 to 610,700 acres in 1904, yielding 869,426,800 pounds, an increase of upward of 190 per cent in acreage, by far the greater increase being in Texas. In 1889 Texas had 178 acres of rice, in 1899, 8,711 acres, while in 1904 the acreage had increased to 376,500, or more than forty-three times the area under this crop six years ago.

PROGRESS IN THE BEET-SUGAR INDUSTRY.

In 1897 there were but nine beet-sugar factories in the country, and the total amount of sugar manufactured was 30,000 short tons. A great change has since taken place, and the estimated output for 1905 is 280,000 short tons.

Extensive practical demonstrations carried on throughout the sugar-beet belt have clearly and positively proved that if the farmers will properly prepare and fertilize the soil, sow a high grade of seed, cultivate and care for the growing crop, and treat it for diseases and insects in accordance with the methods recommended by the Department, not only will their yield be increased but their beets will be of

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better quality and higher sugar content, while the cost of their production will be materially decreased.

The failure of more than one factory has been due to the use of poor seed, and the establishment of high grades of seed has been one of the most difficult problems with which we have had to contend. The Department has, however, within the last year or two, succeeded in establishing farms in sections of the United States where the climate and soil conditions are favorable for the supply of pedigreed seed of superior quality.

Last year one of the largest growers of this seed had to refuse more than 50 per cent of his orders on account of his inability to grow a sufficient quantity of seed. These results warrant the assertion that within the next few years the quantity of seed grown in the United States will not only greatly exceed that grown heretofore, but by its use beet-sugar factories will greatly increase their percentage of sugar extraction. The fact that an increase of 1 per cent in the sugar extraction for last year would have increased the output of refined sugar by more than 40,000,000 pounds is in itself sufficient reason to warrant the Department in exerting every energy to continue the encouragement and assistance it has given to sugar-beet seed growers.

The work the Department has undertaken in establishing single-germ beet seed has proved eminently satisfactory, and it is now assured that a high-grade strain of single-germ seed can be produced, which will greatly reduce the cost of thinning. This will mean the saving of thousands of dollars to farmers throughout the sugar-beet belt, and will give a new impetus to sugar-beet growing.

The yield of sugar beets has been greatly increased not only by scientific cultivation, but by the judicious use of fertilizers, which in some cases have increased the yield from 40 to 50 per cent, and at the same time improved the quality of the beets.

THE ARLINGTON FARM AND GENERAL HORTICULTURAL WORK.

Within the past four years an important increase in the facilities for the work of the Department has been made through the addition of the Arlington Farm. This farm is located near the Arlington Cemetery and contains 400 acres.

From a neglected area overgrown by brush and weeds the farm has been converted into a suitable tract for field and demonstration experiments. Sections are devoted to a nursery, in which the orchard and ornamental plants to be used upon the farm are propagated; a peach orchard of 250 varieties has been planted; an apple orchard of 400 sorts has already been established, and a mixed orchard for experimenting upon the control of orchard diseases has been provided, as well as an orchard for the study of the habits and methods

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of controlling injurious insects. Another orchard has been set aside for testing the effects of cover crops upon the growth and fruiting period of trees. A demonstration fruit garden, a demonstration vegetable garden, and a grass garden have also been features of the farm for three years. Areas are set aside for the growing and testing of forage crops; also for the growing and testing of forest trees, osier willows, and other plants by the Forest Service, various plants and crops for the Bureau of Entomology, and various crops for use of the Bureau of Soils, etc.

A special feature has been made of truck crops in the South. Numerous improvements in the matter of equipment so far as concerns the glass houses on the Department grounds have also been brought about within the past three or four years.

RECENTLY ESTABLISHED FACTS IN TROPICAL AGRICULTURE.

A special branch of the Bureau of Plant Industry has devoted a large part of its attention to various crops suitable for the Tropics.

Coffee has received special study in Porto Rico. Studies of coffee in other regions have been made with a view to profiting by the results obtained in those regions. Several of the supposed principles of coffee culture have been found, on being subjected to scientific study, to have only local application. It has been shown that the value of shade, which is recognized in a number of coffee-growing sections, is due primarily to the fact that the shade trees are of the leguminous family.

Important investigations have been made of the rubber industry in Central America. These studies have developed two important facts: First, that the rubber tree does not require to be grown in regions of great and continuous humidity, as heretofore believed, but thrives and produces better in districts subject to a distinct dry season. The second important fact is that, contrary to previous popular and scientific opinion, the same species of rubber does not extend throughout the Central American region. The reports which the Department has published have served as a warning to the public of the essentially uncertain character of a number of undertakings in rubber culture and have undoubtedly saved to the American public millions of dollars.

Cacao is another crop which has received special study. The cultivation of this crop is confined almost entirely to humid localities, in accordance with the belief that such a climate is necessary to the welfare of the tree. This belief is erroneous, and it is expected that with better cultural methods the growing of this important crop will become an established industry in all the tropical possessions of the United States.

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Millions of dollars are paid annually by this country for tropical products grown outside of our territory. The efforts of the Department have been in the direction of encouraging the production of these crops, as already indicated, in our own tropical dependencies.

ADVANCES IN POMOLOGICAL INVESTIGATIONS.

Along the line of pomological work much of immediate practical value to fruit growers and handlers has been accomplished. Thousands of specimens of fruits forwarded by growers for identification have been passed upon by the pomologist and his expert assistants.

A fairly comprehensive test of a large number of Vinifera grapes on resistant stocks in North Carolina and Florida has demonstrated that certain choice sorts of this type hitherto considered impossible of cultivation in the open air in the South Atlantic States can be successfully grown for home use, at least, when grafted upon such stocks and when thoroughly sprayed to protect against fungous diseases. A systematic and comprehensive experimental investigation of the relative adaptability of resistant stocks to the various soil types of the Pacific slope and of the relative congeniality of the important commercial Vinifera varieties to these stocks is in progress in California. The continued prosperity of the viticultural industry of the Pacific coast, in which over $85,000,000 is now invested, depends in large degree upon the accurate determination of these important questions.

In recognition of the fact that the avoidance of disastrous gluts in our markets is one of the most important factors in developing and maintaining a thrifty fruit industry, special attention has for several years been paid to the encouragement of export trade in American fruits and the improvement of methods and practice in fruit storage and transportation. Comprehensive experimental investigations to determine the best methods of harvesting, packing, handling, and transporting such fruits as are most promising for export have been conducted. Through cooperative experimental export shipments during the last four seasons it has been demonstrated that eastern-grown "Bartlett" pears can be successfully and profitably exported in seasons when the European crop situation justifies the effort.

A large and rapidly developing export trade in eastern-grown "Bartlett" and other autumn pears has developed along the lines pointed out by these experiments. It has been further demonstrated that early varieties of apples from the Middle Atlantic States can be delivered in British markets in excellent condition when proper precautions as to harvesting, packing, and forwarding are observed; also that "Elberta" peaches from Georgia, Oklahoma, and Connec-

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ticut, and later varieties of this fruit from the mountain orchards of Virginia and West Virginia, can be delivered in the United Kingdom in sound and attractive condition whenever the market conditions warrant. It is believed that the establishment of these facts has laid the foundation for a normal and thrifty development of a profitable future export trade in these fruits.

When the Bureau of Plant Industry began the fruit transportation and storage investigations there was little exact information concerning the factors that influence the shipping and keeping qualities of fruits. Very serious losses occur in transit in small fruits and in fruits such as the peach and the orange, as well as in fruit in cold storage. It has not been known whether these losses are due to the cultural treatment, to the methods of handling the fruit, or to the conditions surrounding the fruit in transit and in warehouses. There have been much litigation and many misunderstandings over these difficulties. The Bureau of Plant Industry has succeeded in establishing some of the fundamental factors that govern these questions. It has applied the results to the commercial fruit business of the country in such a way that it has been a distinct benefit to the grower, the shipper, the warehouseman, and the transportation companies.

It has been determined that fruit is not likely to keep well if it is forced to growth. The apple handler has been told to watch the fruit more carefully and sell it relatively early in the season if it has been grown on rank-growing young trees. It has been demonstrated that the apple scald, one of the worst troubles with some varieties in cold storage, can be practically controlled by letting the fruit reach the stage of hard ripeness on the tree, by storing it quickly after picking in a temperature not above 32° F., and by selling relatively early in the season the varieties that are likely to scald. A large proportion of the losses from decay in the transportation and storage of fruit such as the apple and the orange is the result of breaking the skin, thereby making the fruit susceptible to the attacks of the common mold. Fruit is injured by rough handling to a far greater extent than the most experienced fruit growers and shippers have supposed. We have gone into the field and have shown how these injuries occur. Extensive shipping experiments have shown that the losses in injured fruit may be very heavy in transit and in storage, while perfect fruit of the same varieties may be transported or kept in storage in sound condition. It has been clearly proved that the delays that commonly occur in shipping and storing the fruit in warm weather cause the decays and the ripening processes to develop prematurely, and, in connection with improper handling, cause a large proportion of the storage and transportation losses.

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The Bureau has demonstrated that the ripening processes and the development of rots must be checked by cooling the fruit as soon as it is picked. Quick-ripening fruits, like "Bartlett" pears, do not cool quickly enough in the center of a barrel when placed in cold storage, and such fruits should be stored in small packages; fruit that is to be stored several months should be packed in closed packages to prevent it from shriveling; a wrapper lengthens the storage period, and a temperature as low as 32° F. keeps apples of all varieties, pears, peaches, and small fruits longer and in better condition than a higher temperature. It has been shown also that the losses from the ripening of fruit in the top of a refrigerator car may be reduced to an important extent by cooling it quickly, after picking, to a temperature of 35° to 40° F., and, further, that a refrigerator car, kept well iced, will maintain such a uniform temperature if the fruit is first reduced to that degree of cold. These investigations are having an important influence on improving the methods of conducting the fruit industry of the United States.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

In the drug-plant investigations a field study of small areas of many kinds of drug-producing plants has been made in Vermont, in the District of Columbia, and in South Carolina, and it has been shown that many of the most important kinds will do well, e. g., poppy, belladonna, digitalis, wormwood, peppermint, etc. Curing processes have been studied and some of the most important features worked out. A method of utilizing the poppy plant or its parts as a crude source for morphine has been developed on a laboratory scale, and through the Office of Seed and Plant Introduction, a larger test of the commercial possibilities is planned. The production of camphor and licorice is being studied. Distillations from Florida camphor plantations have given a good yield of crude gum camphor. The production of camphor on a commercial scale will be tested in the near future. Certain important wild drug plants threatened with extermination have been successfully brought under cultivation. The utilization of weeds used in medicine has received some attention as a source of profit. American wormseed has been grown in South Carolina as a field crop with a profit comparing very favorably with that of corn, cotton, and tobacco. Yellow dock, burdock, stramonium, and other plants are also being studied. A laboratory and field study of the drug known as pinkroot has shown that this article has largely been crowded out by a spurious article.

The object of poisonous-plant investigations is to study the relation of stock losses to the eating of poisonous plants. Extensive field studies, especially in Montana and other Western States, have shown that great and often sudden losses are not infrequently due to the

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eating of harmful plants growing on the range. The chronic trouble known as "loco disease" is now under study.

TEA-CULTURE INVESTIGATIONS.

In conducting experiments in the cultivation of tea in the South it has been demonstrated that the most important varieties of the tea plant, that from Ceylon excepted, make a growth and give a yield comparing very favorably with the results produced in their own lands. It has also been shown that negro children make expert tea pickers when properly trained. Several new and valuable machines have been invented: (1) A rotary sterilizing machine for withering the leaf to be made into green tea; (2) an attritionizer which at minimum cost polishes the tea, thus enhancing its appearance and market value. A new type of rolling machine is now being perfected to give a better "roll" to the tea than is given by the machines now in use.

Twenty-five acres of tea have been planted at Pierce, Tex., and a preliminary plucking indicates that a very high grade of tea will probably be produced. During the past season 9,000 pounds of tea were made at Summerville, S. C.

IMPROVEMENTS IN SEED DISTRIBUTION.

One of the most important tasks which the Department has to perform is the securing and distribution of the large quantity of seeds made necessary by the Congressional seed distribution. In the earlier work of the Department it was the practice to secure this seed, put it up, and send it out entirely with a departmental force. As the demand for seed increased and the work grew, it was found difficult to handle the complicated questions involved in this way. For a time the handling of the seed for the Congressional distribution was placed in the hands of contractors, but this was found unsatisfactory.

The Bureau of Plant Industry was charged with all matters pertaining to the seed work, and for the past four years has been giving special attention to improvements in the methods of securing, handling, and distributing. The Department has made a special effort to secure home-grown seed from growers and dealers in the United States.

A special effort has been made in the matter of encouraging bulb culture. While the actual number of miscellaneous vegetable seeds distributed has increased, the cost of the work has been diminished and the saving effected thereby has been devoted to the purchase, distribution, and encouragement of the use of improved seeds of various kinds. A special feature has been made of encouraging school garden work through the seed distribution. Formerly it was the practice to send the same kind of seeds to the cities as was sent to the country districts. Now special arrangements have been made

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for placing in the hands of Senators and Members of Congress who have city constituents seeds especially designed for encouraging garden work in the public schools. Circulars of instruction have been prepared and issued with these seeds. Special attention has also been given to the securing and distribution of improved forage-crop seed, cotton seed, and other seeds.

FARM-MANAGEMENT WORK.

The Office of Farm Management has been developed in the Department during the past four years. Until recently its most important work has consisted in the study of farm practice. This study has resulted in finding many farmers who are preeminently successful in their chosen occupation. A careful study of their methods has been made. It has been completely demonstrated that preeminent success in farming consists in combining scientific knowledge with business methods. The publication of the results of these studies has aroused among farmers great interest in agricultural science. Some farmers who are following closely the teachings of agricultural science have been found who regularly secure a net income greater than the price of good farm land in this country.

As a result of the study of farm practice and of scientific investigation, it has been possible to establish object-lesson farms in various parts of the country, and 35 such farms are now in operation. The results obtained on these farms have surpassed expectations. On one dairy farm in the South the net income was doubled in one year. In another instance, a cotton farm with a net profit of $5 per acre was converted into a hay and stock farm with net profits three times the value of the land when work upon it was begun by the Department.

The types of farming prevailing in various sections of the country have been studied, and the cropping systems best adapted to most sections have been determined. Methods of managing farms of different types in different sections have been devised.

Recognition of this work on the part of farmers has been such that the calls for information along these practical lines far exceed the facilities for meeting these calls.

FOREST SERVICE.

During the past year the Government work in forestry entered upon a new phase. Practical work in the actual introduction of forestry began in 1898, but it was not until February 1, 1905, when the care of the National forest reserves was transferred to the Department of Agriculture, that the Forest Service became an administrative organization.

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This transfer was a logical outcome of the recent work of the Service. During the last six or seven years it has passed through a remarkable development, which has followed but not kept pace with its demonstration of capacity for public usefulness. On July 1, 1898, the Division of Forestry employed eleven persons, of whom six filled clerical or other subordinate positions, and five belonged to the scientific staff. Of the latter, two were professional foresters. The Division possessed no field equipment; practically all of its work was office work.

At the opening of the present fiscal year the employees of the Forest Service numbered 821, of whom 153 were professional trained foresters. Field work was going on in 27 States and Territories, from the Atlantic to the Pacific and from Canada to Mexico. Over 900,000 acres of private forest were under management recommended by the Service, and applications on file for advice from owners contemplating management covered 2,000,000 acres more. During the year nearly 62,000 letters were sent out from the offices at Washington, the majority of them in reply to requests for information and advice from the public, of a kind which could not be met by printed information.

This contrast imperfectly indicates the full extent of the change which has taken place, and the progress which has been made. Seven years ago there were in the whole United States less than ten professional foresters. Neither a science nor a literature of American forestry was in existence, nor could an education in the subject be obtained in this country. Systematic forestry was in operation on the estate of a single owner, honorably desirous of furnishing an object lesson in an unknown field. Lumbermen and forest owners were skeptical of the success of forest management, and largely hostile to its introduction. Among the public at large a feeling in favor of forest preservation, largely on sentimental grounds, was fairly widespread, but almost wholly misinformed. It confounded use with destruction, shade-tree planting with forestry.

The real need of forestry was urgent. A time had come which presented at once a great opportunity and a dangerous crisis. Forest destruction had reached a point where sagacious men—most of all, sagacious lumbermen—could plainly discern the not distant end. The lumber industry, vital to the Nation at large, was rushing to its own extinction, yet with no avenue of escape apparent until forest management for future crops should be forced by famine prices. Meanwhile, however, the ruin would have been wrought already.

Timber-land owners were selling their holdings or their stumpage with little evidence of an understanding of their future value, and lumbermen were compelled by business competition to keep down

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the cost of operation to the lowest terms or market their product at a loss.

Forestry was both an evident economic need and an apparent economic impossibility. Few well-informed persons believed that the obstacles to its introduction could be overcome sufficiently to bring it into common practice among private owners during the lives of the present generation.

That the whole situation is profoundly altered is directly and chiefly due to the work of the Forest Service. With its offer of practical assistance to forest owners made in the fall of 1898, its field of action shifted from the desk to the woods. The lumberman was met on his own ground. Uncertain speculations were converted into business propositions and untried theories into practical rules. Actual management for purely commercial ends has been taken up and applied on their own holdings by some of the best known lumbermen in the country. What lumbermen as a body now think of forestry is illustrated by the recent effective movement in their National association to endow a chair of lumbering at one of the forest schools.

Public opinion generally has experienced an equal change, and a sound National sentiment has been created. The great and varied interests dependent upon the forest have been awakened to the urgent need of making provision for the future. States have been led to enact wise laws and enter upon a well-considered forest policy.

Forestry is a matter of immediate interest to every household in the land. Forest destruction is no imaginary danger of a distant future. If it is not speedily checked its effects will sooner or later be felt in every industry and every home. To make these facts known is a National duty. The work of education must continue until public opinion will not tolerate heedless waste or injudicious laws.

PRESENT STANDING OF FORESTRY.

The period which has passed since 1898 has been, in forest work, a period of large definite accomplishments and of effective preparation for the future. Of the exact knowledge concerning our American forests, upon which the practice of scientific forestry depends, vastly more has been gathered during the last seven years than previously from the time Columbus landed. In 1898 the Division of Forestry had hardly approached the specific problems of forest management in the United States, and had developed no efficient methods of attacking them. The records now on file are based on the measurements of millions of individual trees. Commercial tree studies looking toward management have been prosecuted for 32 important species. Working plans have been prepared in 28 States,

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and field work has been conducted in every State and Territory in the United States, and in Porto Rico, Alaska, and the Philippines.

The scientific knowledge gathered in the field has taken form in a rapidly growing literature of the subject, and has furnished the basis for a system of professional education. To-day there is scarcely more occasion for the American to go abroad to study forestry than to study medicine or law.

Besides creating a science of American forestry, the Forest Service has worked out the methods of operation by which forestry may be put in practice. It found in existence a fully developed system of lumbering, which had brought efficiency and economy of labor to the highest point, but was often wasteful of material and regarded forests as simply so much standing timber to be cut. Men taught to regard cheap logs at the mill as the supreme test and sole end of good lumbering, justly proud of their proficiency in a highly specialized industry, and impatient of restraint, could not be expected to welcome with cordiality changes for a purpose whose utility they were necessarily slow to recognize. To work a reform it was necessary to begin with existing conditions and improve them instead of criticising them. Had not the Forest Service taken the lead in finding out just how practical rules for conservative lumbering might be laid down and carried out, forestry could not have reached the point at which it now stands in the United States.

In the field of economic tree planting the same story is repeated and shows definite, important, and permanent results. It is true that in 1898 farmers throughout the Middle West, where tree planting finds its largest field of economic usefulness, were already alive to their need of planted timber. But the knowledge of what kinds of trees to plant and how to make them grow was imperfect. These were the fundamental problems: (1) The comparative adaptability of various species to regional and local conditions of climate, soil, and moisture; (2) the comparative usefulness of the species which can be made to thrive; (3) the protective benefits of planted timber; and, (4) the rate of growth and the future yield which can be expected.

Substantial progress toward the solution of all of these problems has been accomplished. The Forest Service has made in all 300 separate planting plans for private owners, covering an aggregate area of over 50,000 acres, in 36 States and Territories. It has completed regional studies of the broad conditions in the New England States, California, Kansas, Nebraska, Iowa, eastern South Dakota, western Minnesota, Illinois, Oklahoma, and the Ohio Basin in Ohio, Pennsylvania, and West Virginia. These studies largely supersede the necessity of future individual studies on the ground. It is now in a position to exercise great helpfulness in the whole planting

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movement throughout the United States. It has established in the minds of western farmers generally the fact that tree planting can be made successful and that it adds to the money value of their farms. It has also called attention to the great hygienic importance of tree planting on the watersheds; of public water supplies of cities, east and west; has developed practical methods for reforesting denuded mountain slopes and for establishing new forest growth in regions of little rainfall, and has powerfully contributed to the great work of reclaiming desert lands through water conservation and to the whole irrigation movement.

THE GAIN IN ECONOMY OF USE.

The Forest Service has in the last seven years added greatly to our visible forest resources. In the saving of waste it has enriched the country by many millions of dollars, and in this way alone has added vastly more to the National wealth than its total expenditures for all purposes during its entire history.

Its most important achievements in decreasing the drain upon our forests by providing for their more effective utilization have been along four lines—determination of the strength of different kinds of timber, studies of methods by which timber may be made more durable, efforts to decrease waste in lumbering, and the discovery and introduction of better methods of gathering forest products other than lumber.

By its timber tests the Forest Service has established the suitability of various little-used but abundant woods, especially for structural uses, and has made possible the more economical use of other woods by an exact determination of their strength. By its studies of the effects of seasoning and the value of different methods of preservative treatment, it has opened the way to an enormous reduction in the drain upon our forests for railroad ties. What this demand at present is may be realized when it is considered that if a tree were growing at each end of every railroad tie laid in the track in the whole United States all the timber produced would be needed for renewal alone. In other words, two trees must always be growing in the forest to keep one tie permanently in the track.

By its studies of lumbering methods the Forest Service has shown lumbermen how timber formerly wasted in high stumps, tops, and logs left in the woods could be utilized without added expense. And a not less serious waste of a great resource was cut off when the invention of a new method of turpentining made it possible to eliminate the destruction of our southern forests through boxing the trees, and at the same time to gather a far larger value in turpentine than before.

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FOREST EXPLORATION.

Finally, the Forest Service has rendered a great service by its explorations of forested regions. Useful contributions to the knowledge of our forest resources have been made through specific studies of important regions. Such studies have been completed for New Hampshire, Texas, California, the southern Appalachians, and are under way for every important timber region of the country. In addition the organized collection of the facts of production for the entire country has lately been begun. In the West, examinations by the Service have been of great value in selecting forest reserves and locating their boundaries. The guiding principle of this policy is, of course, that all land should be put to its best use. This principle the Forest Service has assisted to put into effect by its recommendations as to what lands should not as well as what should be reserved.

RESERVE ADMINISTRATION BY THE FOREST SERVICE.

The Forest Service had become fully qualified, by its past work, for the responsibility laid upon it by the transfer of the reserves to its administrative charge. The immediate effect of the change was the opening of the reserves to much wider use than ever before. This is the natural consequence of intrusting the care of these great forests to the only branch of the Government which has the necessary technical knowledge. The inevitable consequence of a lack of such knowledge must be the restriction of right use or the practical certainty of misuse. Only under expert control can any property yield its best return to the owner, who in this case is the people of the United States.

Under the system of administration now in force everything affecting the reserves is determined or executed by men of expert knowledge, familiar with local conditions. This entire force has become a part of the classified civil service. Timber is cut only under the supervision of trained men in accordance with a plan carefully prepared to safeguard the permanent welfare of the forest; yet the sales of timber have many times increased since the Forest Service took charge. A far more complete control is exercised than formerly, yet the net cost to the Government of all the work of the Service will be less for the present year than that of the Bureau of Forestry alone before the transfer. A property worth in cash not less than $250,000,000 is administered at a cost of less than one-third of 1 per cent of its value, while increase in that value of not less than 10 per cent per annum is taking place. As the use of the reserves increases the cost of administration must, of course, increase also, but receipts will certainly increase much more rapidly. The forest reserves are certain to become not only self-supporting but a source of large public revenue.

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Work of the Year.

The transfer of the National forest reserves to the care of the Department of Agriculture was effected on February 1, 1905. The administration of these vast forests fell quietly into its place in the Service, and has since been conducted with steadily advancing efficiency. Every office in the Forest Service is actively concerned in their management, working and planting plans are in preparation and have been prepared for various parts of them, and they are absorbing and will continue to absorb a greater and greater part of the work of the Forest Service.

FOREST MANAGEMENT.

PUBLIC LANDS.

On the public lands greater strides were made in the introduction of forest management than ever before. Wherever on the reserves timber is in present demand working plans are being prepared which will insure the best use of the forests. On the Chippewa Indian Reservation, in Minnesota, the complete success of the plan to secure the perpetuation of the forests is assured. In California, Colorado, Montana, South Dakota, and Wyoming studies of leading commercial trees have provided a basis for the intelligent management of the forests in which these trees hold an important place, including many of the reserve forests.

PRIVATE LANDS.

The movement to introduce forest management on private lands is spreading rapidly, especially in the Pacific Coast States and the Middle West. Nearly four-fifths of the applicants for cooperative assistance were small owners. The total area for which assistance was asked was nearly 1,500,000 acres. Examinations to determine the practicability of management were made of 22 large timber tracts in 15 States, and detailed working plans were made for 8 large and 81 small tracts, with a total area of almost 2,000,000 acres.

Cooperative working plans for private land have secured for the Forest Service, at very small cost, data of the most important character concerning the leading timber trees and timber regions of the country. The depletion of supply and the dependence of numerous industries upon our hard-wood forests make the need of a knowledge of how to perpetuate these forests urgent. In the southern Appalachian region and on hard-wood bottom lands of the South Atlantic and Gulf States the studies of previous years have been rounded out, and the Forest Service is now equipped to recommend with confidence practical methods of management for commercial ends.

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FOREST EXTENSION.

Up to the present year the work in extension found altogether its largest field of usefulness in the preparation of planting plans for farm protection and local timber supply in the scantily timbered regions of the Middle West. It is certain that tree planting will always hold an important place in farm economy, but it is more and more becoming possible to supply the needed information for this work from the central office as a result of regional studies. The large projects involved in the establishing or replacing of forests on reserve lands now unforested, and in demonstrating to the consumers of timber that they must provide for their future needs, will probably for the next few years increasingly claim the attention of the Forest Service.

During the year a revision of the terms of cooperative assistance was made to induce wider acceptance by small owners. Up to the present time 380 planting plans have been made, of which 49 were made during the past year.

Reserve planting during the year included the establishment of nurseries in the Santa Barbara and Gila River reserves, broadcast sowing and field planting on the Black Hills Reserve, and field planting in the San Gabriel and Dismal River reserves, besides the extension of previously established nurseries. The experiment in broadcast sowing in the Black Hills is especially notable, because the results obtained now appear to be entirely favorable and because success has never before been gained under this method in this country. The significance of this fact lies in the enormous difference in the cost of reforesting by sowing seed on ground not previously prepared and of rearing and transplanting nursery stock for large areas.

Forest-replacement studies were prosecuted during the year in the Wichita, Prescott, Pikes Peak, Santa Barbara, San Gabriel, San Bernardino, San Jacinto, and Sierra reserves.

By the completion of the cooperative study conducted in the State of California valuable information was secured concerning the relation of chaparral to water conservation and forest renewal and concerning fire protection.

FOREST PRODUCTS.

Lines of cooperative work now completed have brought definite and important results in introducing preservative treatment as a means of increasing the durability of ties, and thereby decreasing the drain upon the forests. The results give good reason for the belief that tie preservation will shortly become practically universal.

The study of the preservation of telegraph and telephone poles promises further economies of the same kind.

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In timber tests, studies of red gum, red fir, western hemlock, and loblolly and longleaf pine have furnished facts which will lead to the wiser use of these species and of structural timber generally. Strength tests of woods for other purposes have been begun, and methods have been prepared for the more extensive prosecution of this very practical work; but the full utilization of the opportunity presented for public usefulness must wait until the necessary facilities are provided.

DENDROLOGY AND FOREST EXHIBITS.

Progress was made during the year in the general study of forest distribution, classification, and composition throughout the United States, especially through regional studies. Previous studies of basket willows and turpentining methods have been continued with further helpful results.

BUREAU OF CHEMISTRY.

During the period begun July 1, 1897, and ended June 30, 1905, the present Bureau of Chemistry has increased its activities, and by reason of its enlarged work was raised from a division to the rank of a bureau July 1, 1901. The work of the Bureau has been seriously retarded, both during the past eight years and prior thereto, by reason of the large number of employees who, having attained a reputation for efficiency and ability, have been induced by superior opportunities of advancement to resign from the Bureau and enter work for other institutions or corporations. Nineteen of the promising members of the Bureau, during these periods, have resigned to enter more lucrative employment in other positions.

CEREAL INVESTIGATIONS.

The chemical investigation of the cereal products of the United States has been one of the principal items of work, and several bulletins have been published embodying the results of the investigations. Starting from the mean composition of the principal cereals, the chemical studies of the products made therefrom have included flours, meals, breads of every description, breakfast foods, cakes, and biscuits. This class of products is not subject to as many adulterations as are other foods. No instance has yet been found of such an adulteration. It frequently happens, however, that cakes colored to a yellowish tint, presumably by the eggs employed in their making, contain, in fact, an artificial color.

The changes which take place in cereal products during the process of milling are fully discussed in the above publications, and the differences, for instance, between the wheat and flour and other products and the bread made therefrom are exhibited in analytical data covering every phase of the process.

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PREPARED MEATS.

Important investigations, also, were made in the study of prepared meats. As a result of these investigations it was shown that the process of parboiling, or "shrinking," as it is technically called, is practiced to produce a marketable article, since meat must be cooked before it is canned. The process was shown to detract little from the muscle-forming elements of the meat. The only substances removed in any considerable quantity are fat, soluble ash, and meat bases. In addition to this work, a systematic examination of the canned goods sold in the American markets was undertaken, and a total of 513 samples of such products were examined. It is interesting to note in connection with this work that in addition to the above 39 samples of horse meat were obtained, designed, according to statements made, for export to foreign countries.

Investigations were made to enable the analyst to distinguish horse meat which might be added to other meats as, for example, sausage. Only one instance, however, was found where it was certain that horse meat had been used in such a mixture.

The investigation of canned meats has proved of particular advantage, both to the manufacturers and consumers. That meat can be preserved unharmed for a long time when thoroughly sterilized in cans has been fully established as the result of the investigations. It has further been shown that it is not necessary in preserving the meat in this condition to add any chemical preservative whatever. The meats thus prepared preserve their wholesome properties and nutritive value and do not lose appreciably in palatability when not kept for too long a time.

FOOD PRESERVATIVES.

Elaborate studies have been made of the character of preservatives used in food products and the best methods of detecting them. These investigations have proved most useful to all workers in this line in the United States and foreign countries.

The natural occurrence in food of some substances used as preservatives has also been made a subject of investigation, as well as the alleged formation of chemical preservatives by the process of sterilization. It has been shown that such a synthesis of chemical preservatives does not take place and that the observations which have led to the contrary assertion are unreliable.

An important investigation has also been made to determine the effect of preservatives and coloring matters, when added to foods, upon the health of the consumer. To this end a class of young men was secured to whom were fed foods containing these articles. In so far as the investigations have been completed, it has been found

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without exception that the addition of the ordinary preservatives to foods is prejudicial to health. The same is true, also, of at least one of the coloring matters commonly employed, namely, sulphate of copper.

The results of these investigations show the need of protecting the public by legislation against the addition of such articles to foods, either by prohibiting their use altogether or by regulating the amount thereof and securing a statement of composition upon the label of each package. In general, it appears that there are wholly unobjectionable ways of preserving food products, which should be followed, namely, by desiccation, by sterilization, or by cold storage. All of these methods are efficacious, but it must be understood that each of them has its limits and that, inasmuch as nature provides every year a sufficient quantity of food for mankind, there seems to be no reasonable excuse for preserving any food product over more than one season.

FOOD STANDARDS.

Important investigations have been conducted by the Bureau of Chemistry looking to the establishment of standards of purity for foods. The results of these investigations have been laid before the food standards committee of the Association of Official Agricultural Chemists, a body authorized by law to advise the Secretary of Agriculture, which has been instrumental in forming the standards already published as well as those which are still under consideration.

The lack of uniformity in the food legislation in the various States is a source of great annoyance to manufacturers and dealers. The Bureau of Chemistry has cordially cooperated with the officials of the various States in their efforts to regulate the manufacture and sale of adulterated foods, drinks, and drugs. It is becoming more and more evident, however, that for the complete control of evils of this kind interstate regulation of commerce in such articles is necessary. For this reason the officials of the various States, as well as the food manufacturers and consumers, are almost a unit in demanding that Congress enact legislation looking to the control of interstate commerce in adulterated foods, drinks, and drugs. Such an act would tend to unify the State laws and bring them into harmony, to give greater effect to the food standards which have been proclaimed under the authority of Congress, and to control in the most efficient manner the evils of food adulteration.

THE INSPECTION OF FOODS INTENDED FOR EXPORT.

The Congress of the United States has authorized the Department of Agriculture, through the Bureau of Chemistry, to inspect all food products intended for export to countries whose laws require a physi-

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cal or chemical inspection of foods. This privilege, however, is optional with the exporter. He is not compelled to secure such an inspection, but is authorized to do so if he so desires. Under this law a great many of the exporters of food products in this country have applied to the Department for inspection of their goods. They have thus been enabled to send with the foods to foreign countries a certificate of inspection, which as a rule is accepted as prima facie evidence of purity. It is evident that our foreign commerce in food products would be greatly promoted if this practice should become general, and our foods would thus acquire a standing in foreign countries which would remove from them all suspicion of impurity.

INSPECTION OF IMPORTED FOODS.

Congress has also authorized this Department to inspect all food products offered for entry into the United States from foreign countries and to refuse delivery to the consignee of all products which are found to contain any added substance injurious to health, or to be misbranded in any particular, either as to their contents or origin, and of such products as are forbidden or restricted in sale in the country from which they come or from which they are exported. In order to carry this law into effect, branch laboratories of the Bureau of Chemistry have been established in the ports of New York, Boston, Philadelphia, New Orleans, San Francisco, and Chicago.

As far as the facilities at hand will permit, all food products entering this country are inspected and analyzed before delivery to the consignee. As a result of this inspection a great improvement in the character of our imported foods has already been secured. There has been developed also among the exporters from foreign countries a desire to send only such articles as may conform to the requirements of the laws of the United States. The law has already been of great advantage to the American consumer, and when the facilities are provided to apply it to practically all imported food products, we may feel assured that in so far as the foreign articles are concerned at least the American consumer will be entirely protected. This is an additional reason, also, for desiring an act of Congress regulating interstate commerce, so that the wise provisions of the law of inspection may be applied also to foods of domestic origin passing from one State to another.

During the period between July 1, 1903, when the enforcement of the law began, and June 30, 1905, 3,576 invoices of food products were inspected, among which 712 were found to be of a character forbidden by law.

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INFLUENCE OF ENVIRONMENT UPON COMPOSITION.

Interesting studies have been and are still being made by the Bureau of Chemistry regarding the influence of environment upon the chemical composition of plant products. The object of these investigations is to show just what factors of environment are most active in producing certain results. When this has once been determined, the enlightened farmer may take advantage of natural forces for the purpose of modifying this crop and making it better adapted to its intended purpose and, therefore, more valuable. One complete series of investigations of this kind has been concluded, namely, with the sugar beet; and it is shown from these investigations that the temperature of the growing season is the dominant factor in determining the sugar content of the beet. The lower the temperature the higher the sugar content. These investigations show the futility of attempting to grow sugar beets in southern regions, even where the soil and other climatic conditions are suitable to the production of crops of large size.

Similar investigations are being made concerning the character of wheat and other crops as affected by environment. These investigations, though strictly scientific, are certain to result in practical applications which will prove of the greatest benefit to agriculture.

TABLE SIRUPS.

Important investigations have been made in the last few years looking to the improvement of the character of the table sirups so largely used in the United States. These sirups are made chiefly from the maple tree, from sorghum, and from sugar cane. These investigations have shown the best methods of procedure in all these cases to secure a product of the highest quality, free from added chemicals. Several bulletins have been published embodying the results of these investigations.

INSECTICIDES.

An elaborate study has been made of the insecticides in use in the United States, in collaboration with the Bureau of Entomology. These investigations have shown that many of the insecticides offered to our farmers are of little value, and that the price demanded and the value of the goods are not always proportionate. These studies have tended to protect the farmers of the country and secure for them a much better quality of insecticide for the money expended.

CONTRACTS.

In the Contracts Laboratory studies are made of the materials submitted for the Department of Agriculture, and other Departments of the Government which may ask for such studies. The results of

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these studies are of the greatest practical benefit in securing for the use of the United States Government materials which fully conform to the requirements of the contract and the character of the samples submitted. The extension of this inspection to all materials supplied the United States Government would undoubtedly prove advantageous.

LEATHER AND TANNING.

Investigations of both a scientific and practical nature were made in connection with the leather and tanning industries of the country. The leather trades have an invested capital of about $356,000,000, and the economic relations of this industry to our forests and our cattle supply have been but little studied. Chemistry plays the most important part in these studies, since it determines not only the amount of tannin and the distribution thereof in tannin-producing materials, but also indicates the methods by which the processes of tanning are conducted. These studies, therefore, have direct practical bearing upon great industries of National importance.

DRUGS AND CHEMICALS.

The importance of pure drugs from the hygienic and remedial standpoint is evident to everyone. Congress has authorized the study by the Bureau of Chemistry of the purity of drugs, their nature, and the sophistications to which they are subject. The Drug Laboratory of the Bureau of Chemistry pursues investigations of this kind, as well as of the purity of chemicals and reagents offered for the use of the Bureau.

COOPERATIVE WORK WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The work of the Bureau of Chemistry in connection with the Association of Official Agricultural Chemists of the United States has been of a most useful character. This association is composed of all chemists connected with agricultural colleges, experiment stations, State and municipal boards of health, boards of agriculture, etc.; hence it represents some of the most important activities in connection with agriculture. By act of Congress this association is made the adviser in certain respects of the Department of Agriculture, and this Department has extended its patronage to the association from the beginning, with great mutual benefit, and still greater benefit to the agricultural interests of the country.

CIDER AND WINE INVESTIGATIONS.

It is well understood that the character of ciders, wines, etc., is due to the chemical reactions which take place during the process of fermentation. Special studies have been made by the Bureau of Chem-

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istry of these chemical reactions, especially with relation to cider, and numerous cultures of yeast, producing specific properties, have been made and distributed.

Careful studies of the wines of this and other countries have also been made which have proved of great practical benefit.

MISCELLANEOUS CHEMICAL INVESTIGATIONS.

Some experiments have been made with apples and peaches to determine just what changes take place in cold storage. An analytical study of tropical fruits, especially those of Porto Rico, was also made.

Salad oils have been investigated, and the extent of the adulteration of olive oil with other edible oils has been ascertained.

Studies of vinegar have been made to ascertain the best methods of distinguishing between cider vinegar and others, such as wine vinegars, malt vinegars, etc.

An investigation has been made to determine the character of the cod-liver oil imported into the United States and the extent of its adulteration.

Studies have been made of the waters used or intended to be used for irrigating purposes. When the help of the Bureau has been asked for by municipalities, water supplies have been studied to determine their sanitary character.

Sanitary studies have also been made of the distribution of arsenic in wares commonly found in domestic use, such as wall papers, fabrics, etc. A large number of such articles have been found to contain quantities inimical or prejudicial to health.

COLLABORATION WITH OTHER DEPARTMENTS.

Under the authority of Congress the Bureau of Chemistry is authorized to collaborate with other Departments which may require its aid. Under this authority work is constantly done for nearly all the Departments of the Government. A large number of investigations has been made for the Treasury Department; also for the War Department, especially for the Commissary-General; for the Interior Department; for the Navy Department; for the Department of Commerce and Labor, and for the Department of Justice.

During the last two or three years the most important of the collaborative work with the Departments is that which has been done in connection with the Post-Office Department. The Postmaster-General submits constantly to the Department of Agriculture for investigation samples of various substances which are intended either to be sent through the mails or advertised in newspapers, magazines, and circulars sent through the mails. Under the law poisonous matters

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and those which are combustible in character or dangerous to other wares are not allowed to be sent through the mails. Samples of such suspicious bodies are constantly submitted for investigation.

There are continually appearing advertisements of remedies said to possess most remarkable characteristics and to effect marvelous cures. Where such advertisements appear to be fraudulent in character, they are submitted, together with samples of the remedies, to the Bureau of Chemistry. After careful examination of the samples and of the literature reports are made to the Postmaster-General, embodying the results of our investigations and the conclusions based upon them. On these investigations and conclusions the Post-Office Department bases its action in either continuing the use of the mails for the distribution of such advertisements or debarring them from the mails as fraudulent. Much benefit must necessarily come to the people of the country from work of this kind.

From the above review of some of the important investigations conducted in the Bureau of Chemistry it is seen that chemistry is a science which touches almost every question connected with scientific agriculture.

From the inception of the Department of Agriculture, by reason of the provision of the organic act establishing it, the services of the science of chemistry have been freely utilized to secure the development and prosperity of the agricultural industries of the country.

BUREAU OF SOILS.

The work of the Bureau of Soils is of such a fundamental character that its results are being more and more widely used, not only by the other Bureaus and Divisions of the Departmental work, but by State agricultural experiment stations and State geological and economic surveys, as a foundation for further work along highly specialized lines. At the same time that the demands upon the Bureau for additional work are increasing, the facilities for accomplishing this work have remained stationary or, in one case, been decreased.

During the past eighteen months the Soil Survey has lost by transfer to the United States Geological Survey, by assignment to alkali reclamation work within the Bureau of Soils, by the cooperation with other Departments of the United States Government and of the Philippine government, by special detail to educational institutions, and by resignations twenty of its most highly trained and efficient assistants. The Survey force, even with these depletions, mapped over 28,000 square miles during the calendar year 1904. With twenty parties of two men each continuously engaged in field mapping, about 35,000 square miles per annum could be surveyed and mapped.

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The Bureau of Soils has on file at the present time requests for the mapping of two hundred and fifteen counties, located in forty States and Territories, and aggregating upward of 150,000 square miles. These requests are supported by 265 organizations and individuals.

Requests are on file either from the directors of experiment stations or from the State geological survey organizations for surveys of all of the areas of several States. The States thus covered include Kansas, Louisiana, Missouri, and North Dakota, and in addition the State organizations of Mississippi, New York, North Carolina, Oklahoma, and Tennessee request that work should be extended as rapidly as possible within their States in order to precede various forms of experimental work or additional survey work in which the State organizations desire to engage.

Requests and petitions from the State of Texas call for the survey of forty-two counties in that State. These requests are indorsed by both Senators from the State, by nearly every member of the Congressional delegation, by several commercial clubs, and by fruit-growers' and truck-growers' associations. Nearly every other State in the Union has furnished similar requests.

The Soil Survey at the present time is equipped with a force of 29 field men and some of the necessary executive and special assistants. In order that the work of this survey may be kept at its former efficiency, in view of the recent depletions, it becomes necessary to increase the number of field men engaged upon actual survey work to 40 persons, thus allowing the maintenance of 20 parties upon continuous field work. On account of the necessity of providing for resignations, for annual leave of absence, and for necessary sick leave, additional men are needed to keep these field parties constantly at their full efficiency. For this maintenance of the field force at least 12 more men are required for the Soil Survey service. To keep in close touch with all of the work as it is being conducted in the field and in order that the necessary correlations of the soils of one area with those of other areas which are in progress of mapping or have already been mapped may be made, it is necessary to have two inspectors, both highly trained men, appointed from the present Survey force, who will visit each area during the progress of the work and advise the men in regard to all difficulties which can not be solved through correspondence. Through their personal contact with the men the inspectors will keep the field work up to the highest state of efficiency and economy. The places on the Survey thus made vacant would need to be filled by the appointment of two new men at smaller salaries.

The men required to supply these additional places can only be obtained from a limited number of sources in the United States at the present time. While several of the agricultural colleges are

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training men along various lines of soil investigations, only a few of these colleges are equipped with men who can train students in the actual practice and conduct of soil-survey work. As a result the Soil Survey has to depend largely upon men whose training is of a general rather than a special character, and these men must receive additional training before they can be placed in charge of the important work of soil mapping and soil classification.

The character of the work already accomplished and the broad scope of the problems encountered in the areas already surveyed are shown by a recapitulation of the work of the Soil Survey from its inception to June 30, 1905. All of the problems encountered in the field require additional research work in the laboratory for their complete solution. This is particularly true of the two great problems of American agriculture which concern, respectively, the arid lands and the humid lands of the United States. The first study concerns the accumulation of soluble salts, known as alkali; the second problem is that of soil fertility, or, as it is sometimes stated, that of "worn-out soils." Both of these problems are being studied by the laboratory force, and the results obtained are published in the form of special bulletins, which summarize the scientific facts discovered, and also in the form of circulars or additions to the Soil Survey reports, in order that the results may be placed in such a form as to constitute a practical working basis for the persons whose farms are concerned. In the same way the Tobacco Investigation work follows and supplements the Soil Survey. Recently arrangements have been made whereby cooperation has been secured with certain agricultural experiment stations and with the Office of Farm Management of the Department of Agriculture. Through this arrangement it is hoped to come into very close touch with all branches of American agricultural activity.

EARLY WORK OF THE SOIL SURVEY.

The first work of the Soil Survey consisted of preliminary studies of the tobacco soils of the United States and of the alkali soils of the Yellowstone Valley. These investigations showed that a field map could be constructed which would represent graphically the classification, occurrence, and distribution of distinctive types of soils. It was also found that in the arid regions of the West a second map should be constructed which would show the amount and character of the alkali, which frequently interferes with crop production or totally prohibits it. It was also found in the case of the arid regions that a map showing the depth to permanently saturated soil was necessary. For this reason, in the conduct of soil surveys in the arid regions, a soil map, an alkali map, and a ground-water map are prepared, whereas in the humid regions the soil map alone is sufficient.

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Each of these survey maps is accompanied by a report upon the climatic surroundings of the region, its transportation and market facilities, and the special adaptation of different crops to the different soil types, together with an outline of the transportation problems and of such other commercial, economic, and other essential facts as directly influence agricultural welfare and agricultural life.

THE VALUE OF THE SOIL.

The soils of the United States are considered as the greatest natural economic endowment of the American people, far exceeding in the value of their annual products all of the returns secured from mines and fisheries. It is the purpose of the Soil Survey work to outline the most economical method of securing the utmost efficiency in the handling of these soils and in the production of food products from them. The questions involved concern not only the farmers themselves, but also every person interested in labor, commerce, manufacturing, or professional life. The problems are fundamental.

The studies thus far made of the soils of the United States include the survey of 197 separate areas, located in 44 States and Territories. These surveys aggregate 63,621,120 acres, or 99,408 square miles. They have been so distributed as to constitute a study of soil conditions in all the different physical divisions of the United States and for all of the chief staple crops. In addition, the special conditions favoring the production of special crops under intensive methods of agriculture have also been studied.

Surveys of the tobacco soils of the United States have been made in 16 different States. Their results show that the variety of leaf produced is controlled largely by the texture of the soil upon which the crop is raised. Thus, the heavy clay soils produce a thick, gummy leaf, while the lighter sands produce wrapper leaf and bright tobacco.

The soils of the truck-producing regions along the Atlantic and Gulf coasts have been studied from Rhode Island to Texas. It has been found that the Norfolk sand is the best soil for the production of early truck crops in all of the tide-water districts of the eastern coast line. Where market facilities and transportation are favorable the land values upon the Norfolk sand have risen from $5 or $10 per acre under general farming conditions to $100 or $200 per acre for the production of sweet potatoes, early Irish potatoes, melons, small fruits, and small vegetables. The interior truck regions of the Central States have been similarly studied, and in this region the Miami sand has been found to be the type of soil best adapted to truck farming.

The grape soils of the United States have been studied in the Lake Erie region and in California. It has been found that the sandy and

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gravelly soils adapted to the production of the eastern wine and grape-juice grapes do not furnish a product well suited for shipping, and the production of table grapes for distant markets is best accomplished upon the heavy clay and shale-loam soils of what is known as the Dunkirk series. In the California grape belt of the San Joaquin Valley the alkali problem was found to be serious. The soil-survey work around Fresno has been followed by alkali reclamation work. It has been shown that with an expenditure of less than $40 per acre soils which have decreased to the value of $20 or $30 per acre for grass and grain production can be restored to their former value of $350 to $700 per acre for grape production.

STUDY OF APPLE SOILS.

The apple industry has been served in two notable instances. The soil survey of the Lyons area in Wayne County, N. Y., was followed by an orchard survey made under the direction of the horticultural department of Cornell University. Thus, a map showing the adaptation of apples to the various soils has been supplemented by a comprehensive bulletin which discusses the question of the varieties to be raised for commercial marketing, the methods of culture and the fertilizer to be employed, questions of storage and shipment, and even the facilities offered by the different domestic and foreign markets. In the same way the great pippin belt of Maryland, Virginia, and North Carolina has been studied. It was found that the profitable production of pippins was confined to a single soil type—the Porters black loam—occurring in the coves and small valleys of the eastern ranges of the Allegheny Mountains. It was also found that not only were the most successful orchards located upon this soil type, but also that a distinct climatic belt also existed within which the pippin production was especially favored. On account of differences in latitude this belt descends from higher elevations in the South to lower elevations northward. In Virginia it occurs between altitudes of 1,200 and 3,000 feet.

SOILS ADAPTED TO CITRUS FRUITS.

On the Pacific coast extensive studies have been made of the soils adapted to citrus fruits. Here it has been found that not only the soil played an important part in the location of groves of citrus fruits, but that the alkali problem and the conservation of irrigation water constituted dominating factors. The use of irrigation water containing considerable amounts of soluble salts for the safe irrigation of citrus and pomaceous fruits has been studied in this district. The melon-producing areas around Rockyford, Colo., and Indio, Cal., have been studied and the soils best adapted to the production of high-grade

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cantaloupes determined. It is found that the fine sandy loams of both regions, under proper irrigation conditions, constitute the best melon soils.

SUGAR-BEET SOILS.

In conjunction with the extension of the sugar-beet industry into eastern areas, it has been found necessary to take up the study not only of eastern sugar-beet soils, but the study of the soils upon which sugar beets have long been produced to advantage in the irrigated districts. It has been found that the soils best adapted to raising sugar beets in the arid regions are not at all the soils adapted to sugar-beet production under humid conditions. In the former the sandy loams and adobe soils constitute the main sugar-beet producing types. In Wisconsin, Michigan, northern Ohio, and central New York the heavier loams or clay loams well supplied with moisture and still not too stiff to interfere with root development constitute the best soils for this crop. In Michigan and northern Ohio these soils are the Clyde loam, Clyde sandy loam, and Miami black clay loam. All of these are dark in color and contain considerable quantities of partially decayed organic matter. In New York the Miami stony loam and Miami silt loam are the soils upon which the best results are obtained.

ALFALFA SOILS.

The introduction of alfalfa into the Eastern States and its production under humid conditions have necessitated a study of alfalfa soils from New York to Alabama and Texas, and also throughout the central prairie region. While the soil factor is not the only one controlling the introduction of this crop, it has been shown that when other conditions are reasonably favorable the Miami stony loam of the Northeastern States almost invariably gives the best results for alfalfa growing. Similarly, in the Gulf Coast States, when proper drainage can be secured, the Houston black clay or the black "waxy land" of the Cretaceous prairies, as it is locally known, constitutes a soil type upon which alfalfa grows almost spontaneously.

RICE AND SUGAR CANE SOILS.

The rapid development of the rice industry in Louisiana and Texas within the last decade has necessitated a study of the soils of that general region. It has been shown that under the modern conditions of production, with the use of heavy power machinery and under copious irrigation, the heavier silt loams and clay loams of the low-lying Louisiana and Texas prairies are best adapted to this modern industry. The Crowley silt loam, Lake Charles fine sandy loam, and other similar types are the ones upon which this crop is meeting with the greatest success.

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The sugar-cane interests have been served by a number of surveys along the Gulf coast. One area of special interest was mapped around the sugar station of the Louisiana Experiment Station. The results obtained upon the soils mapped in this area can readily be applied in connection with the same soil types mapped in the other Gulf coast areas.

While the Soil Survey is thus serving numerous special interests and in a great many instances obtaining new results which are striking and gratifying, the total value of these is possibly small compared with that which comes from a study of the soils which produce our great staple crops like grass, wheat, corn, oats, and cotton.

IDEAL CORN SOILS.

The study of soil conditions in the great central cereal belt of the United States has demonstrated that three types—the Marshall silt loam, Marshall loam, and the Miami black clay loam—are beyond dispute the ideal corn soils of the central prairie States. The study of the extent and distribution of these three types, whose products dominate one great branch of American agriculture, has led to a better understanding of the conditions which lead to successful corn production. As the studies of corn breeders have led to new inspiration in the plant side of corn production, so the delimitation of these types of soil so admirably adapted to the production of maize will furnish direction for increased specialization in the selection of the best possible soil conditions for corn production.

At the same time it has been shown by the soil surveys that the typical corn soils of the central prairie States are not at all the most desirable corn soils for the northeastern and eastern tide-water States. Owing to greater elevation and a consequent shorter season the corn crop can be matured only upon those soils which are at once well drained, well warmed, and sufficiently retentive of moisture to satisfy the demands of a heavy, rank-growing crop. So in New York and the northeastern States in general the gravelly and stony loams lying below an altitude of 1,500 feet constitute the corn soils.

Again, in the Piedmont and Coastal Plain regions of the southern seaboard States it has been found that another entirely different set of conditions must be met. Corn does not thrive below an altitude of 100 feet, just as it is not successfully cultivated above 1,500 feet. Again, certain climatic peculiarities intervene to alter conditions of production. As a result the heavy loams and clays of the Cecil and Penn series and the heavier loams of the Orangeburg and Norfolk series constitute the soils best adapted to corn culture in these regions.

In addition to these uplands suited to corn production in the Southern States the narrow alluvial bottom lands, frequently subject

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to overflow, are found to constitute by all means the best corn soils of the region, and only their limited extent and the difficulty of protecting them from destructive inundation prevent these soils from being recognized as among the most desirable of any in the United States for corn production. The problem of the proper protection of these bottom lands, either by watershed forestation or by local levees, constitutes one of the most important problems of local production of provision crops throughout the South.

SOILS ADAPTED TO SPECIAL CROPS.

Several soils of the Northeastern States upon which an unsuccessful attempt is being made at the present time to produce cereal crops actually constitute the best grass lands of the region. This is particularly the case of the Volusia silt loam of northeastern Ohio, northern Pennsylvania, and southern New York. This soil lies at an altitude of 1,300 to 2,000 feet above sea level, and the production of corn is an uncertainty on account of the occurrence of unseasonable frosts. As a result, the farming population of this general district, particularly in the hill lands, is becoming discouraged and disheartened, while the soil with which they are dealing is admirably adapted to the production of grasses, oats, and buckwheat. The abandonment of grain farming and the turning to dairy industry and stock raising, based upon hay and oat production, would seem to be highly desirable throughout this general region.

STUDY OF COTTON SOILS.

A constant study is being made of the cotton soils of the Southern States. These communities have shown wonderful progress both in agriculture and manufacturing during the past decade. The study of soils in the Yazoo and Red River basins of Mississippi and Louisiana has shown ideal soil and climatic conditions for the continued production of maximum cotton crops. The annual overflows naturally enrich the plantations and render the soils subject to this influence of almost inexhaustible fertility. It was pointed out in the Yazoo report that the chief problem of these regions was to secure adequate protection from destructive inundation, while still securing the fertilizing benefits of the overflow waters.

Similarly the Upland cotton regions have been found to present two dominant soil problems. The first is that of preventing the bodily removal of the fertile surface soil through erosion; the second is that of securing such a rotation of crops and use of green manures as will restore the organic matter to soils depleted by long-continued clean cultivation in one crop. Both of these problems can be met and are being met by enterprising farmers in nearly every community where soil surveys have been made. The mere statement of these

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problems and the accounts given of cases where their solution has been worked out are of inestimable value to the planters whose attention has not formerly been called to the work already done by their own neighbors and by their local authorities.

ARID AND SEMIARID REGIONS.

The introduction of durum wheat into the regions sometimes deficient in rainfall, but not naturally arid, requires a careful investigation of the soils to which this new crop is best adapted. So soon as the proper soil conditions can be ascertained there is a good prospect that a vast region marked formerly by uncertain harvests can become dependent on a totally new industry adapted to its peculiarities of soils and climate.

The interests of agricultural areas as yet undeveloped have also been served. The new irrigation areas of the arid States are being investigated and maps made which show not only the kinds of soils which exist and their proper crop adaptation, but also the locations of land too alkaline to be of any present value for crop production.

PRACTICAL UTILIZATION OF THE SOIL SURVEYS.

Surveys of single areas of this description have furnished prospective settlers with information which has prevented the unwise investment or total loss of thousands of dollars, in many instances constituting every dollar possessed by the individual. At the same time these settlers have been directed to lands within the same areas where their investments could be made with safety and their new homes established without risk of disappointment. The actual settler has thus been benefited, and new communities have secured advance information which only years of bitter experience would have furnished them under their own undirected efforts.

It will thus be seen that the Soil Survey reports and maps concern not only those engaged in the broad study of economic agriculture and its resources in the United States, but that they are of high value for daily use by a great variety of agricultural and commercial interests. The increase of the use thus made of the maps and reports is evidenced both by the requests received for reports already published and by the requests which are continually being made for additional surveys. It is possible only to enumerate the interests which make these requests. These include canning companies, granges, farmers' clubs, and other agricultural organizations; the leading educational institutions, not only those practically interested in agriculture, but also those which study agriculture as a portion of the economic system of the United States; the geological departments of the leading universities, and botanical, geological, agricultural, forestry, and

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irrigation surveys. The use of these maps by individual farmers, and particularly home seekers and those desiring to engage in special intensive forms of agriculture, is rapidly increasing. This is shown by the fact that maps of areas which are being developed along new lines of fruit growing, trucking, or market gardening are in great demand by individuals. Thus, Long Island, N. Y., Wayne County, N. Y., Norfolk, Va., and other areas mapped in the older settled States have met with the largest demand for single copies of the report and map of any of the areas published during the last two years.

MAINTENANCE AND RESTORATION OF SOIL FERTILITY.

The study of the main agricultural question of the humid sections—that of maintaining soil fertility, or of restoring lands to their former crop-producing power—has been taken up. It has been found through centuries of experience that there are three chief methods for maintaining the fertility of soils. The first of these—manuring or fertilization—is most generally practiced in the United States; the second method—crop rotation—is also widely practiced, and its importance is becoming thoroughly understood; the third method—that of proper culture or tillage, which would include drainage and irrigation—is of more modern origin, so far as the American people are concerned, and is less thoroughly understood and less widely practiced. A study of the relative values of each of these methods and of the relationship of each to the other must be made in order to meet the requirements of recent growths of agriculture in the United States. The broad areas of virgin soil which formerly existed in the United States invited the most superficial cultivation. Crop rotation was neglected or carried on in a haphazard fashion. Under mismanagement and unwise methods, engendered by long periods of abundant cheap land, the time must sooner or later arrive when the soils do not respond to cultivation with profitable crops. Recourse is then had to some form of fertilizer. This point has already been reached in certain portions of the United States.

NEW METHODS FOR TESTING FERTILIZER REQUIREMENTS.

In order that the restoration of these lands through the application of different manurial and fertilizer compounds may be accomplished most economically, the problems of soil fertility and of soil management have been taken up by the Bureau of Soils. New methods have been devised for testing the fertilizer requirements on each of the principal soil types encountered by the Soil Survey. This method gives results in about six weeks' time which have been found to be practically comparable with the results of plot experiments carried on over longer periods. The new method has been tested against the

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fertilizer and manurial plots of two leading experiment stations, one in Rhode Island and one in Ohio. The results of these tests have been highly satisfactory, not only to the Bureau of Soils, but also to the directors of the two stations. Letters from them are on file which show their appreciation of this new line of work. In order that the method may be completely tested, work has been arranged for the ensuing year in cooperation with four additional stations.

The parties assigned to this work will study not only the manurial requirements of soils occurring at the stations, but they will also study the fundamental questions of the principles involved in the maintenance of soil fertility. In addition to this use of the new methods devised in the Bureau laboratories, work is being carried on for the determination of the manurial requirements of each of the principal soil types of the United States as they are encountered in the different areas which are being surveyed. The soils from thirty-nine different localities have already been investigated and a circular giving the results of these investigations has been published in three of these cases. It will thus be possible in connection with each survey to include directions for the fertilization of each of the different soil types encountered, with the reports upon the areas as they are published. It is only natural that investigations into such fundamental problems as those concerning soil fertility and manurial requirements should attract general attention and bring numerous comments from other investigators along the same lines. This has been more pronounced in the fertility studies, because not only the results obtained, but also the viewpoint and even the methods employed, were essentially new. It has been found necessary, in addition to the publication of the usual bulletins and circulars, to meet many of these inquiries by lectures upon the principles of the work and by exposition of its method of operation before the faculties and students of several scientific institutions. As these methods are becoming more thoroughly understood they are being gradually adapted for scientific work along the same lines by investigators who are working outside of the Department of Agriculture.

RECLAMATION OF ALKALI LANDS.

Another of the important problems of American agriculture—that of the control of alkali—chiefly concerns the arid regions of the United States. As a result of the very first survey work in such areas, it became manifest that certain methods should be employed to prevent the accumulation of alkali in irrigated lands and to reclaim those lands which had already been damaged by accumulations of soluble salts. This situation was met in earlier reports by recommendations concerning proper methods to be employed, but it was

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found that in order to bring this matter convincingly before the people most concerned and to get them to follow the recommendations made, it would be necessary to conduct actual demonstrations; consequently in 1902 the work of the Alkali Reclamation Service was begun upon the Swan tract, near Salt Lake City, Utah. This tract has been thoroughly underdrained, and frequent applications of irrigation water have been made by the method of flooding. After three years this land, which at the inception of the demonstration produced only greasewood and saltbushes, has produced fair crops of wheat and alfalfa. At the expiration of another year this tract should be completely reclaimed, and in addition should produce good yields of farm crops adapted to the soil and climate.

Similar demonstrations have been undertaken in Montana, Washington, California, and at an additional station in Utah. These demonstrations will be completed in about the same time required for the original Swan tract. This reclamation of alkali land by thorough underdrainage, on account of the expense involved, is adapted only to the reclamation of lands of relatively high value.

TEXAS TOBACCO SOILS.

In Texas the possibilities of certain soils of the Orangeburg series for the production of high-grade filler tobacco have been investigated by field parties with headquarters at Palestine, Anderson County, and with substations in Nacogdoches County and Houston County. Experimental fields aggregating 103 acres have been planted in cooperation with thirty-four different farmers. The entire production of the Texas fields has already been bought by a Chicago firm at a very satisfactory price, and it was bought before the crop was even fermented. It is thus evident that a ready market for the Texas product can be secured.

The people of this general region are totally unskilled in the technical details of the production, curing, and marketing of tobacco. At the same time, the invasion of the boll weevil has rendered the introduction of some crop in addition to cotton highly essential to the welfare of this agricultural community. It is therefore necessary for the Department to maintain these tobacco stations in this region long enough to encourage and advise the individual farmers in firmly establishing this new line of crop production. A great interest is taken in this tobacco work by individuals and business organizations in eastern Texas. The same line of work has been taken up in Alabama, around Marion, with the same general results.

TOBACCO WORK IN OHIO.

In Ohio the Bureau has practically finished its experimental work. The crop grown upon 32 acres in cooperation with eight

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different farmers in Montgomery County was purchased at very remunerative prices even before it was cut. The work of tobacco fermentation in cooperation with the Ohio tobacco men has been continued. This is the fourth season for this line of work, and practically all of the Ohio packers have now abandoned the old practice of case fermentation, substituting the Bureau method of bulk fermentation. This change has resulted not only in the saving of thousands of dollars formerly lost through imperfect curing and through black rot, but it has also added materially to the profits of all tobacco by a general improvement in the quality of the different crops.

TOBACCO WORK IN VIRGINIA.

Work has been extended in the dark-tobacco districts of Virginia, where tobacco growers were securing very unsatisfactory returns for their labor. A station was established in Appomattox County and a number of experimental plots established upon the Cecil clay. Different methods of fertilization and of handling were tested. The result of a single season's work indicates that the methods introduced by the Bureau of Soils will result in profits on the investment of fertilizer and labor of from 13 to 35½ per cent. These conclusions are drawn from the results of actual field experience. Although only one year's work is concerned it has been clearly shown that by a judicious use of fertilizers and with thorough and proper cultivation it will be possible for the Virginia tobacco raiser to increase his yield and his profits materially.

SHADE-GROWN TOBACCO IN CONNECTICUT.

The work in the Connecticut Valley upon shade-grown wrapper leaf has been continued. The object of this work is to develop a type of tobacco which at the same time is adapted to the soil and climatic conditions of Connecticut and to the market demands. During the year nearly 100 bales of this tobacco have been sold for domestic use. The prices obtained range from 20 cents per pound to $1.75 per pound, with an average of 75½ cents. Eighty-six bales unsuited to the domestic demands were sold for export at prices ranging from 10 to 70 cents per pound, with an average price of 27.8 cents per pound.

MISCELLANEOUS TOBACCO WORK.

The tobacco work of the Bureau of Soils includes the improvement of domestic filler tobacco through the introduction of the Cuban seed-leaf industry into the Southern States and into Ohio; the introduction and supervision of the bulk fermentation process in

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Ohio; the completion of the experiment for producing a shade-grown wrapper tobacco in Connecticut which will meet trade requirements; improving the fire-cured types of shipping tobacco in Virginia; and it is very desirable that investigations of the same kind should be made in the tobacco districts of New York, Pennsylvania, Maryland, Wisconsin, Kentucky, and Tennessee.

Requests for this work have been received from many farmers, from various tobacco growers' associations, and from a variety of trade interests. The importance of this work is obvious, and the Bureau is prepared to carry on and enlarge this line of work in the future as rapidly as appropriations can be made available.

BUREAU OF ENTOMOLOGY.

The work of the Bureau of Entomology during recent years has greatly increased, and beneficial results have been obtained in many lines of work, while several new and important branches of investigation have been entered upon.

THE MEXICAN COTTON BOLL WEEVIL.

The large-scale experimental work made possible by the emergency appropriation of Congress was carried on to the close of the season of 1904, and was taken up again in the spring of 1905. The territory infested by the boll weevil had unfortunately considerably increased both northward and eastward by the close of the season of 1904, at which time it covered approximately 98,000 square miles in Texas and Louisiana.

EXPERIMENTAL FARMS.

The territory in question probably exhibits as great variation in rainfall, temperature, and other particulars as any area of like size in the United States. Therefore it was necessary to establish fourteen experimental farms, where all sorts of experimental work were carried on. The adaptability of the weevil to new conditions, as has been shown by its having acquired an ability to become perfectly acclimated in the United States, is also witnessed in local variations due to climatic and other conditions. The general cultural method was tested in these various localities, as well as the benefit of planting selected varieties, of fertilization, and of thorough cultivation to accomplish the same result and at the same time to cover the infested squares with earth. Important and suggestive conclusions were reached which will have an important bearing on modifications of the general system.

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LABORATORY WORK.

Much work was done at the laboratory with various remedies proposed for the boll weevil, including Paris green, which at one time attracted great attention. Experiments were also performed with the object of discovering feasible means of destroying weevils in cotton seed and other articles. Over 220,000 experiments were made during the past year. These dealt with dissemination, natural control, habits, various features of hibernation, and other points. A careful record is kept of the condition of the weevils on the experimental farms, and these records show the exact progress of infestation during each season. Consequently the causes that have contributed to a sudden increase at any time can definitely be determined, and this work therefore has a direct bearing upon the possibility of reducing the damage by the pest. Especial attention was paid to the possible effect of birds in controlling the boll weevil, and large numbers of birds' stomachs were collected and their contents carefully examined. In connection with the laboratory work experts were sent to watch the advance of the pest along the northern and eastern portions of its range. This has resulted in a great amount of information as to how the pest reaches new regions, and furnished the basis for publication of maps showing the territory infested.

COOPERATION WITH THE LOUISIANA CROP PEST COMMISSION.

This cooperation was continued and an energetic attempt was made by the State to check the further advance of the weevil. Five experts were placed at the disposal of the State authorities, and were stationed at various points where the progress of the weevil could best be investigated. While the Louisiana authorities did not succeed in checking the advance of the weevil, many important features of the dissemination of the pest have become well known, and the knowledge gained will be of direct benefit to other States which may at any time attempt to prevent invasion by the pest.

It has been known for some time, as pointed out in publications of the Bureau of Entomology, that the late summer and autumnal work of the cotton-leaf caterpillar is detrimental to the progress of the boll weevil. The early fall destruction of the leaves, when this is at all complete, exposes the boll weevil to the action of the sun, which is inimical to it and deprives it of its food supply. The extensive defoliation of the cotton crop in September and October, 1904, in Texas is in a measure responsible for the late start of the boll weevils in the summer of 1905. In Louisiana this phase of the cotton question is much more marked than in Texas. The cotton caterpillar is present every season, and planters generally poison against it. If the late poisonings are omitted and the caterpillar is allowed to increase,

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the dense foliage of the cotton plant, which is so abundant in the moist bottom lands of Louisiana, will be done away with and the autumnal ravages of the weevil decidedly checked. In this fact lies possibly a practical measure of considerable importance.

COOPERATION WITH THE TEXAS STATION.

Two experts were stationed at the Texas Agricultural and Mechanical College and under the direction of the State entomologist made careful studies of other insects injuring cotton.

POSSIBILITY OF CONTROLLING THE WEEVIL AT GINS.

It has been evident for some time that gins have been very important factors in disseminating the boll weevil, and during the year this subject has been investigated very carefully. An especially trained expert was employed in this work, and a large number of experiments were carried on with gins in actual operation. Important results were obtained, and a series of recommendations have been sent to all ginners in the infested territory, by the observance of which, and at no very great expense, the danger existing from these establishments may be totally overcome.

INSPECTION OF FARM PRODUCTS QUARANTINED AGAINST BY STATE LAWS.

Nearly all of the cotton-growing States quarantined against certain products of Texas, on account of the danger of introducing the weevil. Some of the rules operating under State laws were too stringent, and at the suggestion of the Bureau they were modified by several States in order to permit the shipment of such products as should be certified by the Bureau as not dangerous.

THE COTTON BOLLWORM.

An investigation of this dangerous insect carried on and concluded within the past few years has resulted in the ascertaining of a complete knowledge of its habits and life history and in the elaboration of a system of treatment which will reduce its ravages in the southern cotton fields to a minimum. The investigation has been concluded and the final report published. The work that is still being carried on with regard to this species is demonstration work undertaken to show cotton planters on a large scale that the recommendations of the Bureau are sound.

THE INTRODUCTION OF BENEFICIAL INSECTS.

Very important results have been gained in the introduction of beneficial insects. One of the most striking of these results is the importation and establishment of the fig-fertilizing insect of south Europe.

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This was established at Fresno, Cal., with almost immediate results of great interest. A properly planted orchard had existed at that point for some time, but efforts to import the fertilizing insect had failed. As a result of the Department's efforts, the insects were brought over alive and were thoroughly established, enabling, after one year, the production of 10 tons of Smyrna figs of a quality slightly superior to those imported from Europe. The crop has continuously increased, new orchards of Smyrna figs have been set out in parts of California, and a new industry has been established as a result of this importation.

The black scale has for many years been a serious enemy to the citrus and olive crops of California, and although a ladybird enemy of the scale had been imported from Australia, it was efficacious only in certain portions of California, not thriving in other portions where these crops have a great monetary value. After several unsuccessful attempts to establish a parasite, known as *Scutellista cyanea*, from Italy, it was found that this species also inhabits South Africa, and from that point specimens were introduced which at once took hold in California and have multiplied with such rapidity as to prove of enormous benefit to the growers of oranges, lemons, and olives.

The native home of the San Jose scale was found by one of the experts of the Bureau to be northern China, and from that point he secured specimens of a ladybird, known as *Chilocorus similis*, which were brought to Washington, propagated in numbers, and sent out to different portions of the United States infested by the San Jose scale. The insect does not seem to do well in the Northern States, but has become established in the Southern States. It is prolific and will probably maintain itself and become more and more useful every year. The lime, sulphur, and salt wash and other remedies for the San Jose scale, however, have proved so efficient and are so cheap as to be practically universally adopted, and this adoption takes away the possibility of a very rapid multiplication of the imported ladybird.

An interesting antlike insect, known as the "kelep," was discovered in 1904 in Guatemala by an officer of the Bureau of Plant Industry, and was found to be such an important enemy of the cotton boll weevil in that country as to hold it distinctly in check and to permit the cultivation of cotton where otherwise it would be impossible on account of the weevil. Colonies of this insect have been introduced into the United States, and while it is as yet impossible to state whether it will establish itself and become an important feature in cotton cultivation, it promises good results, and the fact has at least been established that in tropical regions it may be used to very great advantage.

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A systematic effort has been begun within the past summer to import the European and Japanese natural enemies of the gypsy moth and the brown-tail moth. The Chief of the Bureau visited Europe and secured very many parasites and sent them to Massachusetts, where they are being cared for. The trip has demonstrated effectually that the natural enemies of these two important insect pests may be easily brought from Europe to the infested territory in the United States, but it is as yet too early to state whether they will establish themselves in such a way as to afford relief. The outlook, however, is hopeful.

THE SENDING OF USEFUL INSECTS ABROAD.

During this period many sendings of important parasitic and predatory insects have been made to foreign countries where it was thought they would be of assistance in warfare against injurious insects. The most striking instance of the value of this work occurred in 1898, when the orange groves of Portugal were threatened with extinction by the ravages of the white scale. The officials of the Portuguese department of agriculture appealed for assistance, and through the cooperation of the State board of horticulture of California specimens of *Novius cardinalis*, the ladybird enemy of the white scale, imported from Australia into California by an employee of the Bureau some years previously, were secured. The Entomologist had these specimens carried in the refrigerating compartment of a steamer to Portugal. The success of the experiment was almost immediate and very great, and the scale was practically annihilated in a little more than a year.

Parasites of American scale insects have been, and are still being, sent to the official entomologists of Italy, France, and other countries, and good results are constantly being secured. No results, however, have as yet proved as striking as those in Portugal, just described.

WORK ON SCALE INSECTS.

Careful investigations have been made into the habits and life histories of very many species of injurious scale insects, and the Bureau has built up what is probably the largest collection of these insects in existence. Its publications on the life histories of these insects are standard, and its especial publications on the San Jose scale are the basis of all of our knowledge of this important pest. The work of the Bureau on remedies for scales has been very extensive, and for the past eight years has formed an important part of the output of the Bureau. Nearly all of the standard remedies against this class of insects are the result of these labors.

When various foreign governments passed regulations forbidding

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the importation of American plants and fruits, on account of the danger of introducing the San Jose scale, some of the edicts went too far, and forbade the importation of unpeeled American dried fruits. An important investigation was therefore carried on to determine the effect on the San Jose scale of the different methods in use in this country in drying fruits for exportation. The results showed the unnecessary nature of the foreign regulations, not a single scale having been found which showed the slightest signs of life after drying by any of the processes in use. The result of this investigation was of distinct benefit to dried-fruit exporters, and necessitated the revision of the laws of several foreign countries.

INSECTS INJURIOUS TO FRUIT AND FRUIT TREES.

While scale insects form many of the important enemies of orchards, there are many others which have also been investigated. In 1901 the necessity developed for a careful investigation of the codling moth in the Northwestern States, where it seemed the remedies applied in the East were not effective. It was supposed that the difference in climatic conditions had brought about a change in the life history and habits of the insect which rendered eastern remedies less useful. Consequently a thorough investigation was carried on, which lasted for three years and cleared up all doubtful points in life-history conditions as applied to the Northwest, and resulted in the publication of results which have been of great value to the fruit growers of that region. In the course of this investigation demonstration work was carried on in one of the largest orchards in Idaho, and fruit growers from different parts of Washington, Oregon, and Idaho were invited to inspect the methods and the results. Many did so, and were convinced of the value of the work. Fruit growers in California and other States have written to the Department stating that their operations had been rendered much more profitable as the result of this investigation.

While more or less work against fruit insects has been constantly carried on, an effort has been organized to make a very especial and widespread investigation of this class of pests, and several experts have been assigned to the work, which is now being carried forward on a broad scale.

INSECTS DAMAGING FORESTS.

Beginning with 1899, an investigation of the damage to forests by the work of insects was begun by the Bureau of Entomology in cooperation with the Bureau of Forestry. The importance of these investigations was immediately recognized, and they have been extended until they form a distinct section of the Bureau's work. Many important results have been reached. In 1902, for example,

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great loss of pine timber, to an amount of more than 226,000,000 feet (board measure), was found to have resulted in the Black Hills Forest Reserve from the work of a bark beetle mining under the bark of living trees.

An investigation resulted in the discovery of practical methods by which the ravages may be entirely checked. The cost of carrying out the recommendations is not great, and the investigation means not only the saving of threatened loss of forest property valued at many millions of dollars, but also the prevention of the crippling of great mining and commercial enterprises representing many more millions. In the course of this work especial cooperation has been entered into with lumbering companies, manufacturers of wooden articles of trade, importers of exotic woods, and forest rangers, which is rendering the work more efficient and bringing it close to the people directly interested in its results.

INSECTS INJURIOUS TO STORED FOODS.

An extended investigation has been made of insects injurious to stored foods. The full life history of practically every species known has been worked out, extensive experimental work has been carried on with remedies, and a thoroughly practical and efficient system of fighting these insects has been ascertained. The publications of the Bureau on this class of insects have been in great demand among grain and milling men, and the efficacy of the Bureau's recommendations is undoubted. The number of species of insects which infest stored food supplies is very great, and the labor of working out the full life histories has been prolonged and arduous.

INSECTS WHICH CARRY DISEASE.

Special and important studies have been made of certain of the insects known to carry disease, with results of great importance. The publications of the Bureau on the subject of mosquitoes have been in great demand by members of the medical profession, and to a large extent the knowledge we have in this country of the mosquitoes which carry malaria has been due to the work of this Bureau. Important studies have also been made of the yellow-fever mosquito, and the quarantine regulations of the Public Health and Marine-Hospital Service, in the recent yellow-fever emergency, are based on the results of this work. The Bureau was a pioneer in work against mosquitoes, and its constant reiteration of the possibility of controlling mosquitoes has been in a large measure the cause of the large-scale antimosquito work now being carried on.

The Bureau has also paid special attention to the study of the house fly, especially in relation to its agency in the carriage of disease.

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These studies revealed the very great danger that exists of the carriage of typhoid fever by the house fly and by certain other insects. This investigation is the only one of its kind that has ever been carried on, and its results are considered of great value by the medical profession.

INSECTS AFFECTING LIVE STOCK AND FIELD CROPS.

Studies of the insects affecting live stock have been continued, and new material of value has been published about several of the more important. An investigation into the natural history of the cattle tick is now being carried on, which will have an important bearing on the cattle industry of the South, since upon such an investigation may depend the important question of rotation in pasturage to do away with the so-called Texas, or splenetic, fever.

Careful studies have been made of a number of the principal field-crop enemies of the country, and as a result special bulletins were published on the Hessian fly, on the chinch bug, and on the general subject of insects injurious to grains and grasses.

SILK CULTURE.

In 1902 the Bureau began once more, after an interruption of a number of years, a systematic effort to introduce the culture of the domestic silkworm into the United States, and this effort has continued since that time. Guaranteed eggs were purchased in Italy, mulberry cuttings of best varieties were also purchased abroad, manuals of instruction in the raising of silkworms and in the care of silkworm food plants were issued, and two silk reels purchased in France. Two skilled French reelers were brought over from France, and remained in Washington for some months instructing several American girls in the process of reeling thread from cocoons. The eggs purchased abroad were sent, on application, to all persons in the United States who possessed mulberry trees, upon the leaves of which the worms are fed. Persons not possessing mulberry trees were supplied with cuttings, rooted seedlings, or seed of the mulberry.

Following the instructions given in the manuals, the correspondents of the Department raised their silkworms, harvested their cocoons, and sent them to the Department, for which they were paid the current European prices. The cocoons were then reeled by the Department's employees, and the silk resulting will eventually be sold. This process has been repeated each year. The establishment of commercial filatures in the United States without a guaranteed crop of cocoons is obviously an impossibility. Therefore it has been the aim of the Department to get mulberry trees planted in favorable situations, to educate as many people as possible in the care of the worms, and, by purchasing the cocoons, to keep its correspondents interested and engaged in the culture until the time comes that the establishment

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of commercial filatures will be possible. The recent invention of silk reels which greatly reduce the cost of reeling and the establishment of colonies of Italians and others skilled in silk culture at different places in the United States seem to point to the establishment of the industry before long.

WORK IN APICULTURE.

There have been carried on during the period mentioned certain investigations in bee culture which have in the past year become extended and which promise to be of much assistance to the keepers of bees in the United States. The lines of work being carried out are principally in the studies of bee diseases, in the investigation of new forage crops, and in the introduction and establishment of valuable races of bees from other parts of the world.

OTHER INVESTIGATIONS.

A number of investigations of scarcely less importance than those mentioned have been undertaken and completed, or partly completed, during the past eight years. Important studies have been made of injurious insects liable to be imported from other countries, and these studies are valuable from the fact that injurious insects from abroad are constantly being brought in. The ready recognition of such imported pests is necessary, and as the result of these studies several recently imported insects of menace to agriculture have been recognized and stamped out.

Extensive studies have been made of insects affecting truck crops, and many bulletins giving remedial measures have been published.

Insects affecting tobacco have been studied with care, and the results published. The same may be said of insects affecting gardens and greenhouses.

Every year a tour of investigation throughout the Western States has been made by an expert to study the grasshopper conditions and to be able to predict the locality of any threatened outbreak. Careful experiments on a large scale were carried on with a fungus which kills grasshoppers reported to be very successful in South Africa. The results of this investigation were negative, owing to the climatic conditions which prevailed in parts of the West in which grasshoppers abound.

A great deal of work of a systematic character in the study and classification of insects has been done. Entomologists of the agricultural experiment stations and others rely upon the Bureau for work of this kind. The large force of experts in the employ of the Bureau and the possession of large collections and a large library at Washington render this a center for inquiries of this class. The amount of time employed in this work is very great, but the results are

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of value in an indirect way, since they assist in the labors of the station entomologists and render them more accurate. Along the same line a careful bibliography of all published matter relating to American economic entomology has been kept up and has been published from time to time for the use of American economic entomologists and others.

Careful work has also been done on the geographic distribution of injurious insects, indicating the spread of imported species and the portions of the country inhabited or not inhabited by every injurious insect of first-class importance.

SAVING FROM INSECT LOSSES RESULTING FROM THE WORK OF THE BUREAU.

Some indication of the cash value of the work outlined should be given.

The boll weevil, which in 1904 caused the destruction of $22,000,000 worth of cotton in Texas, did not prevent, in that year, the production of the largest cotton crop grown in this State, and the very regions where the crop in the earlier years of the invasion of the weevil had been utterly destroyed produced cotton this year in very profitable quantities. The enormous cotton crop of Texas for 1904 affords an evidence of the value of the methods of control elaborated by this Bureau. In the case of the bollworm, which has caused a loss annually of about $12,000,000 throughout the cotton-producing area of the South, the careful experimental field work of this Bureau has shown means of preventing a very large percentage of this loss, and these means of control are being gradually adopted, to the great profit of cotton growers.

The methods of controlling the San Jose scale, the most important pest of the deciduous fruit trees in this country, are so effective that commercial orchard growers no longer fear this scale insect. The proof of the efficiency of these methods and their general exploitation have largely come about within the last eight years, and chiefly as the result of the experimentation conducted by the Bureau of Entomology. The saving effected amounts not only to millions of dollars in value of the fruit product, but also to the very life itself of the trees and the continuance of large commercial orchard enterprises. The cost per tree of this treatment is not heavy, but it is expected that this charge will be still further reduced by the importation of natural enemies of the San Jose scale.

The saving which has already resulted from work against the insect enemies of forests is illustrated by the outcome of the investigation in the infested Black Hills district. Here a loss of more than $10,000,000 worth of timber occurred in a single year. Simple and effective means of preventing repetitions of such losses were discovered.

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In the case of stored products, such as cereals, tobacco, and woolen and manufactured goods, the processes of fumigation with bisulphid of carbon and hydrocyanic-acid gas, which have come into general use during the last eight years, are preventing enormous losses every year. The annual loss in stored products is probably fully 5 per cent, which gives the enormous total of $100,000,000, and certainly one-half of this loss can be prevented by the proper use of the fumigants mentioned. These same fumigants are also coming into very common use for the eradication of insect pests in houses and stores, and the saving in this field is already very great.

The lessening of the diseases due to mosquitoes and house flies, such as malaria, typhoid fever, and yellow fever, has been very greatly assisted by the investigations of the breeding habits and means of controlling these pests conducted by the Chief of the Bureau of Entomology. The cash value of such work is almost beyond computation when the stagnation of business enterprises and general commerce which results from epidemics of yellow fever and, to a less extent, of typhoid fever and malaria, is considered. The same is true of insect parasites and disease conveyors affecting domestic animals.

Many other items of equal importance could be added relating to field-crop insects and insect enemies of fruits and other farm and orchard products. In the case of the latter more particularly the benefits resulting from the work of the last eight years have been in continuation and accentuation of work of earlier years, but a good share of the present benefits must be ascribed to the increased effectiveness and knowledge gained by the more recent investigations.

BUREAU OF BIOLOGICAL SURVEY.

The work of the Biological Survey began in 1885, and at first consisted chiefly of the study of the food habits of birds and mammals for the purpose of determining their exact relations to agriculture.

A second line of investigation was soon added, for it was perceived that the distribution areas of indigenous plants and animals were closely correlated with those of cultivated crops. The determination of the boundaries of the natural life zones of the United States and the corresponding crop zones, therefore, became an important division of the work of the Survey.

In 1900, as a result of the passage of certain Federal laws, a third division of the work, that of game protection and introduction, became necessary.

The work of the Survey is now pursued along these three distinct lines.

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DETERMINATION OF LIFE ZONES AND CROP ZONES.

Early attempts at agriculture in the United States were necessarily almost wholly experimental, and the particular locality, climate, and conditions suited to special crops were ascertained only after many and costly individual trials. The chief purpose of a biological survey of the several States is to ascertain and make known, by means of maps and reports, the boundaries of the natural life zones, together with the physiographic and climatic conditions that determine them. The life zones of a State once ascertained with precision, the farmer is greatly aided in selecting the crop best adapted to his own district and, what is scarcely less important, in avoiding crops unsuited to it. Thus the uncertainty and cost of farming experiments may be greatly reduced.

In a publication entitled "Life Zones and Crop Zones of the United States" the life zones of the country were defined and mapped, and the adaptation of various crops to the several zones was indicated so far as the data collected to 1898 permitted. Future and more detailed work in the several States will enable the life zones to be defined with greater precision and the selection of crops to be made with great accuracy.

Biological field work in the State of Texas, which was begun in 1899, has been completed and final reports are being prepared. A report already published contains an account of all the mammals and reptiles of the State, with especial reference to their economic status. The life zones of the State are defined and, as a means of identifying them, the mammals, birds, reptiles, and plants characteristic of each zone are specified.

A biological survey of California was begun in 1891 and is far advanced toward completion. Its size, peculiarly diversified surface, its mountains and deserts, and its climatic conditions render California a difficult field for biological surveys, while the varied resources of the State and its immense agricultural interests make the work exceedingly important.

Work in outlining and mapping the life zones of Colorado and New Mexico along lines similar to those indicated above was begun in 1904, and is progressing satisfactorily.

Preliminary work has been carried on in most of the States whose agricultural interests are large, and detailed surveys of the several States will be undertaken as rapidly as means and the exigencies of work already begun permit.

Investigations in Alaska were begun in 1899, when the increase of population and growing commercial importance attracted attention to that Territory. Little accurate information was then avail-

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able regarding the game and fur-bearing animals which add so largely to the resources of the region. Moreover, important problems connected with the study of the life zones and crop zones of the United States could not be solved satisfactorily without contributive data from more northern regions. An assistant, therefore, has been engaged in field work in Alaska each season since 1898, excepting 1901 and 1905, and the results are found to have an important bearing upon many phases of the work of the Biological Survey. Of particular value has been the direct knowledge of local conditions thus obtained, which is necessary for use in connection with the administration of the Federal game law of Alaska. A part of the results of these investigations has been published in three faunal reports. Other reports of similar nature are in preparation.

From 1900 to 1903 a small party of the Survey was engaged in studying the geographic distribution of birds, mammals, and plants in the Boreal and Arctic zones of Canada, particularly for the purpose of connecting the results of work in Alaska and the home territory by means of investigations in the intervening regions. Part of the results appeared in 1902 under the title "A Biological Investigation of the Hudson Bay Region," and a report upon the work in the Athabasca and Mackenzie valleys is nearly ready for publication.

In 1897 the work of the Survey was extended into Mexico for the purpose of tracing into that country the life zones of the United States, to determine the northern limits of the tropical zone of Mexico, to ascertain its extent within the United States, and to obtain a knowledge of the distribution, abundance, and habits in Mexico of American plants, birds, and mammals. A general zone map of Mexico has been completed, and a large amount of scientific and economic data is on file.

ECONOMIC ORNITHOLOGY.

This section of the Biological Survey is engaged in the study of birds in their various relations to man. Two principal lines of investigation are followed. In the first, the habits of birds are studied in the field, especially with reference to their food. Orchards, gardens, and grain fields are visited in order to determine whether birds damage crops, attack insects, both injurious and beneficial species, and to what extent they feed upon wild fruits and weed seeds. In this field study it is desired to enlist the cooperation of every cultivator of the soil. In the second, stomachs of birds are examined in the laboratory and their contents tabulated. In addition to the stomachs collected by our own assistants, many are obtained from ornithologists throughout the country. From 1885 to 1897, 24,000 stomachs had

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been collected, and of these about 12,000 had been examined. Since then stomachs have been received at an average rate of more than 4,000 annually, and the number is constantly increasing from year to year. The total number now on hand is about 66,000.

In 1903 an article was published upon the "Economic Value of the Bobwhite," in which the salient points in the food habits of this valuable bird were brought out. Attention was paid also to birds in their relation to bee culture, as complaints had been made that birds destroy bees.

In 1904 a preliminary article upon the work in California, begun in 1901, was published, in which the conditions attending fruit growing in that State were briefly reviewed and the birds of economic interest were discussed.

The constantly increasing ravages of the cotton boll weevil have created an urgent demand for accurate knowledge of the food habits of insectivorous birds in the cotton districts, and during the past two seasons assistants of the Biological Survey have made a special study of birds in relation to the destruction of the boll weevil. As a result of these investigations a bulletin on the subject has been published, and considerable additional data have been gathered.

ECONOMIC MAMMALOGY.

In connection with the study of the geographic distribution of mammals, field naturalists are instructed to observe particularly the food habits of each species, to secure data concerning their relation to the farmer, whether beneficial or injurious. Many stomachs have been examined and others are now on hand awaiting examination.

During the past eight years experiments in the use of poisons and other means for destroying noxious mammals have been made, both in the laboratory and in the field. Rats, prairie dogs, ground squirrels, rabbits, field mice, and pocket gophers have been the subjects of these experiments.

Special reports on prairie dogs, ground squirrels, pocket gophers, jack rabbits, and coyotes have been published, and investigations concerning these and other mammal pests are being continued. A great mass of notes on the habits of mammals has been accumulated, and reports on the economic relations of field mice, beavers, wolves, and skunks are now in course of preparation.

Experiments with fences to protect sheep and other domestic animals from the depredations of coyotes, dogs, and other predatory animals are in progress in cooperation with farmers in Oklahoma and Kansas.

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GAME PROTECTION AND INTRODUCTION.

The duties of the section of the Biological Survey devoted to supervision of game protection and introduction grow out of three acts of Congress: Act of May 25, 1900, commonly known as the Lacey Act, requiring supervision of importations of wild birds and animals from foreign countries and of the preservation of the birds and game of the United States; act of June 3, 1902, requiring supervision of the importation of eggs of game birds; and act of June 7, 1902, requiring supervision of the preservation of the game of Alaska.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Since the passage of the Lacey Act, May 25, 1900, constant vigilance has been exercised to prevent the entry of injurious species of birds and mammals. The annual importations of birds and animals are large, and include canaries and miscellaneous cage birds, shipped mainly from Germany, Australia, China, and Japan; a few pheasants and other game birds, for liberation or confinement in aviaries, and rare birds and animals for the various zoological parks of the country, brought in chiefly at New York and San Francisco; pheasants for aviaries imported from Canada at ports along the northern border, and parrots and monkeys from Mexico and Central America, entered at southern ports. Inspectors have been appointed at seven of the principal ports to examine all large shipments or such as may possibly contain injurious species.

During the five years ending June 30, 1905, 1,591 permits have been issued for the entry of 1,006,964 birds (principally canaries), 2,846 mammals, and 38 reptiles, and 13 for the entry of 6,500 eggs of game birds. Of the consignments entered 402 have been inspected. To prevent inconvenience in cases where no danger exists, the requirement of permits for reptiles and a number of species of well-known mammals was removed at the end of the first quarter of the operation of the law. So far as is known, no injurious species have been entered. Seven mongooses, 54 flying foxes or fruit-eating bats, 1 kohlmeise, 15 blaumeisen, and 2 starlings have been refused entry, and either killed or reshipped to the original port of shipment. Six keas were refused entry at Honolulu.

INTERSTATE COMMERCE IN GAME.

Through cooperation with the Department of Justice and game officials throughout the United States 166 violations of the Lacey Act, involving the shipment of 24,424 head of game and 2,608 plume birds, have been investigated, and 49 convictions have resulted. Of the convictions 30 were secured in Federal and 19 in State courts.

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In addition to securing convictions for violations of law, great effort has been made to secure observance of both the Federal and State laws. Summaries of the principal provisions of the game laws of the United States and Canada have been issued annually and widely distributed, and several publications on special subjects have been prepared.

Aid in framing satisfactory laws has been extended to State officials and legislators; the conditions of illegal traffic in game have been carefully studied and in special cases have received personal investigation, and copious correspondence and many personal interviews have been had with State game officials with a view to securing better legislation and more rigid observance of the laws. To this phase of the Department's duties railroad and express companies have lent cordial and valuable cooperation.

PROTECTION OF GAME IN ALASKA.

Thorough supervision of game protection in Alaska has not been possible because of the limited means available for this purpose. With the cordial cooperation, however, of the Treasury Department, through its customs officials at Port Townsend, Seattle, San Francisco, and various points in Alaska, a rigid surveillance has been maintained of all exports of game trophies and specimens from the Territory. During the three years the law has been in operation 155 permits for such exports have been issued, under which 93 trophies were shipped, including heads of 29 moose, 38 sheep, and 3 caribou, as well as several consignments of specimens for scientific purposes. Owing to expressed local dissatisfaction with the law a bill materially modifying it was introduced into Congress in the session of 1904–5. For this reason it was deemed desirable to further restrict the issue of permits. and very few have been granted during the present year.

BIRD RESERVATIONS.

It is well known that certain favorable localities form breeding places for large colonies of birds. Such localities offer tempting marks to those who gather eggs or plumage for commercial purposes, and if these depredations are unchecked complete extermination of certain species is sure to result. Within the past three years three such breeding grounds have been converted by the President into bird reservations. Pelican Island, a breeding resort for pelicans, off the coast of Florida, was so set apart on March 14, 1903; Breton Island and two smaller islands off the coast of Louisiana, a breeding ground for gulls and terns and a wintering resort for hundreds of thousands of ducks, were reserved on October 4, 1904, and four small islands in

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Stump Lake, North Dakota, which form a breeding colony for many ducks and other water birds, on March 9, 1905. The Department cooperates in the establishment and regulation of these reservations.

ACCOUNTS AND DISBURSEMENTS.

In this Department the keeping of accounts and disbursement of funds are assigned to the Division of Accounts and Disbursements. The report of the Chief shows the work of the Division to be in good shape. Of the $6,094,540 appropriated by Congress about $800,000 remained unexpended at the close of the fiscal year, but most of this sum was covered by liabilities. The accounts for 1903 have been finally closed, and an unexpended balance for that year of $281,615.16 has been covered into the Treasury.

The estimates for the current fiscal year (1906) amounted to $5,697,810, of which $1,388,490 was for the Weather Bureau. It should be stated that the estimates and appropriations mentioned here do not in any case include the $720,000 annually appropriated for the support of the State Agricultural experiment stations. Congress made small reductions in many of the estimates, but large increases in several others, so that the total appropriations exceed the estimates by $292,880. This increase does not include $190,000 appropriated for continuing the cotton boll weevil investigations, nor $950,000 appropriated for the new Department buildings, which subjects were not included in the Department's estimates. The large apparent increase in appropriations for salaries resulted mainly from the fact that employees formerly paid from "lump-sum" funds have been placed on statutory rolls. The largest actual increase was one of $330,180 in the appropriation for the Forest Service, which resulted chiefly from the transfer of the National forest reserves from the Interior Department to this Department.

DIVISION OF PUBLICATIONS.

THE WORK OF PUBLICATION.

At this time, when the publication work of the Government is the subject of considerable discussion and not a little criticism, it is meet and proper that this branch of the work of this Department should be presented clearly to the public.

DIFFUSION OF INFORMATION AUTHORIZED BY LAW.

In the organic law which created this Department it was made the duty of the head of the Department to diffuse just as much as to acquire information of value to agriculture. While the Secretary is authorized to diffuse this information by all means at his command, the most obvious method, the most economical, the most available, is

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to put this information in print. Inasmuch as the acquisition of any information of value to agriculture imposes on the Secretary the duty of making it public, it is obvious that the work of publication must grow with the growth of the Department. Every line of inquiry authorized and undertaken by the Department implies necessarily the publication of results.

GROWTH OF PUBLICATION WORK.

Under the circumstances it is not surprising to find that whereas in 1897 the total number of publications was 424, in 1905 the total number was 1,072, and whereas in 1897 the number of printed pages of original matter was 11,715, in 1905 the number of printed pages of original matter was 20,000. The unavoidable growth of the publication work of the Department has been from the first the subject of my earnest consideration, and every effort has been made toward economy consistent with the duty presented above of making speedily available to the public whatever valuable information has been acquired. The practice has been adopted of restricting the size of the editions as much as possible with a view to preventing the accumulation of undistributed publications, and reprints have been resorted to from time to time in the case of publications for which a continuous demand was found to exist. Especially has this been true of publications of a technical character.

WATCHFULNESS IN THE DISTRIBUTION OF PUBLICATIONS.

Objections have been urged against the publication and distribution by this Department of bulletins of a technical character. The answer to these objections is that many of our publications are unavoidably scientific or technical in their character, being the practical record of scientific investigations by scientific men, the value of whose conclusions must necessarily bear the scrutiny of scientific investigators the world over. The elimination of all scientific terms and language from such reports is impossible. In this connection it is well to call attention to the fact that the average edition of these more technical or scientific publications is about 2,000 copies, and distribution to others than specialists, libraries, and educational institutions is very insignificant. For popular use the great bulk of publications has appeared in the form of inexpensive pamphlets, such as, for instance, the Farmers' Bulletins, which constitute nearly one-half of the total number of publications issued. Every possible care is taken in the distribution of our documents to minimize the waste inseparable from any system of gratuitous distribution.

The permanent lists of the several Bureaus, Divisions, and Offices are kept within as narrow bounds as possible, the policy of the

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Department being to widely advertise its publications as they appear and confine the distribution almost entirely to persons applying for them. A fair test of the demand for the Department publications is furnished in the records of the Superintendent of Documents, from whom the publications of the Department may be obtained by purchase. This official reports the sale during the year 1905 of 68,000 Government publications, of which more than 38,000 were publications of this Department.

FARMERS' BULLETINS.

Of the Farmers' Bulletins there were distributed upon the orders of Senators, Representatives, and Delegates in Congress 4,782,643 copies during the past year. Unlike the Yearbook and other publications of the Department especially ordered by Congress, the Farmers' Bulletins are not delivered to the folding rooms of the Senate and House, subject to the order of members, but are held in this Department and are distributed mainly under addressed franks furnished by them. Moreover, under the law providing for this class of publications, all those remaining on hand of the 80 per cent provided for the use of Congress revert to the Department and are thus made available for redistribution.

One feature of the Congressional distribution deserves to be specially noted, and that is that the proportion of Senators, Representatives, and Delegates failing to use their quotas is very much less than heretofore. The fact that the number of Farmers' Bulletins left over from the 1st of July last was less than the year previous by over a million copies has resulted in a reduction of the Congressional quota of the current year from 15,000 to 14,000 copies.

THE YEARBOOK.

The Yearbook of the Department is published annually in an edition of 500,000 copies, as provided by the act governing the public printing and binding approved January 12, 1895. Of this enormous edition, however, but 30,000 copies are placed at the disposal of the Secretary of Agriculture, and of this number 27,000 or 28,000 are reserved and sent to active correspondents who have in some way earned, by actual services rendered, a right to such recognition, leaving the number in the hands of the Secretary for miscellaneous distribution but about 2,000. It may be stated here that the total number reserved for the Department, namely, 30,000, is just the same as it was twenty years ago, when the total edition was 300,000. Of the 200,000 additional copies printed since then not a single copy finds its way to the Department itself, and every business day of the year scores of letters are written by the Department explaining

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to applicants, including even those who have certain claims upon the Department, our inability to supply them with the Yearbook; this notwithstanding that, as has been recently shown, thousands of copies remain stored in the folding rooms of the Senate and House undistributed and unavailable—a condition of things, however, which it is obvious the head of this Department is powerless to affect. Investigation would probably show that a similar condition exists in regard to many other of the publications printed by order of Congress and reserving a considerable quota for Congressional use.

A FRUITFUL SOURCE OF EXTRAVAGANCE.

The provision of the law already cited, which limits to an edition of 1,000 copies all publications of this Department exceeding in size 100 octavo pages, has proved a fruitful source of extravagance. While designed, undoubtedly, merely to effect the limitation of our publications to small-sized pamphlets, a limitation which it has been the general policy of the Department to encourage, the actual effect has been to compel application to Congress for a larger edition, such action almost invariably involving provision for several thousand copies for the use of members, and this even in cases such as the Beet Sugar Reports, where only a minority of the members was interested in the subject. Some of these publications have been printed and reprinted by order of Congress, such as the Report on the Diseases of the Horse, and the Report on Diseases of Cattle, and others, the total editions in some cases aggregating hundreds of thousands of copies, where no application for such provision was ever made by this Department, and in many cases where no provision was made for a single copy for the use of the Department.

From the foregoing it is obvious that in the matter of printing this Department occupies a unique position, it being the Department's special duty to print, and to print abundantly; that in the aggregate nearly one-half of all the copies of its publications are issued subject to the order of Senators and Representatives; that economy is practiced both as to style of publication and in the manner of distribution; that a determined effort is made to restrict the number of copies of the publications of the Department to the actual demand existing for them.

The total number of documents distributed was 12,089,653 copies, the actual mailing, correspondence, and clerical work in connection therewith involving work of considerable magnitude and difficulty. It is gratifying to report, however, that the distribution has been unusually prompt, the average length of time required in filling miscellaneous requests for publications having been reduced to an average of two days. This result has been rendered possible largely owing to increased facilities and improved service.

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DEMAND FOR PUBLICATIONS FROM EDUCATIONAL INSTITUTIONS.

Unfortunately, under the limitations imposed upon the Department either by the printing law or the available appropriations, the actual demand for publications is far beyond our ability to supply. A very large proportion of the correspondence of the Division of Publications consists of letters explaining our refusal to comply with what seem to be perfectly reasonable requests for Department publications. One feature of this demand deserves special notice. Of late years the demand made upon us for publications in bulk for class work in institutions of learning, for use at farmers' institutes, and from others of the very numerous and rapidly increasing agencies seeking to promote agricultural education has multiplied tenfold. While this is a most encouraging feature from an educational and sociological point of view, it is truly discouraging to be able to meet only a very small proportion of these demands, and rarely to be able to comply with any of them in their entirety. It is of no use to allege the existence in large numbers of undistributed publications of this Department in the folding rooms of the Senate and House, this supply being entirely beyond the reach of the Department, and serving only, as its existence is reported from time to time in the public press, to stimulate demands upon the Department and to make more difficult to the minds of many applicants our explanations of inability to satisfy their requests.

INDEXING THE PUBLICATIONS.

One of the important features of the work of the Division of Publications recently established on something like an adequate basis is that of a general and comprehensive indexing of all the publications of the Department. It is of the utmost importance that this indexing scheme should be fully carried out in regard to all of our publications—past, present, and future. The existence of such a complete index would pay for itself over and over again.

REPORT TO JOINT COMMITTEE ON PRINTING.

This Department furnished to the chairman of the Joint Committee on Printing of the Senate and House of Representatives a statement showing the publications issued by this Department during the fourteen years ended June 30, 1905, giving the number of copies of each edition printed, the cost of each publication, the manner of distribution, and the number of copies on hand July 1, accompanied by replies to the several interrogatories contained in the request for the information furnished, together with certain recommendations in regard to the public printing and binding.

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BUREAU OF STATISTICS.

THE DEVELOPMENT OF THE BUREAU.

The statistical work of the Department of Agriculture, begun in 1862, has developed into wide use in serving as a basis in establishing prices of farm products. The relations and mutual interests of agriculture, commerce, and manufactures, and of consumers of farm products, are now so vast and so complex that the necessity of issuing impartial crop reports by this Bureau is generally recognized. The needs of all interests require that there be published at frequent intervals during the crop season by a disinterested agency reliable information of the acreage, condition, production, and value of the principal crops, also reports of live stock, by States and by total crop areas, to serve as a legitimate basis for current prices. When this work was begun the value of farms and farm equipment was about $7,000,000,000; now it has reached nearly three times that amount. Of the $5,000,000,000 worth of annual farm products a much larger per cent than formerly is sold off the farm and enters commerce and manufactures.

The industries depending on agriculture have grown to vast proportions, and not only manufactures, but transportation and mercantile business are in more sensitive touch with the products the farmer can sell and with his power to purchase than ever before. Trade has become vastly more complex, partly owing to the rapid development of reselling on close margins to take advantage of fluctuations in prices, and of dealing in futures and in options. The development of organizations to fix prices and of other organizations to force temporary changes in prices, giving unnatural advantages to price manipulators, has led the public more and more to recognize the need for a strong and impartial agency to make comprehensive reports of actual facts relating to prospective crops and yields, that all concerned may know how to buy and sell.

THREE CLASSES OF CROP REPORTS.

There are three classes of statistical reports of agricultural products prepared by the Federal Government.

(1) The census of agriculture, issued every tenth year by the Census Bureau of the Department of Commerce and Labor, giving a census count of all acreages and yields of crops and reports concerning farm animals, the last census having given the figures collected in 1900 of the crops and live stock for 1899. The reports of the Census Bureau, coming out one year in ten, after the crop of that year is harvested and sold, serve only as a basis and a check, making it possible for the Bureau of Statistics of this Department during the succeeding ten years to more accurately estimate amounts of crops in prospect or

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amounts actually harvested. The reports of this Bureau could be made more accurate if an agricultural census were taken every five years instead of every ten, providing bases of comparison not so far removed.

(2) The monthly and annual reports by the Bureau of statistics of agriculture, giving acreage, condition, yields, and prices of crops, and reports of live stock, serve as bases for current prices.

(3) These monthly reports, expressed numerically for entire crop areas, serve also as bases for more frequent reports of changed conditions caused by marked weather changes as reported by the Weather Bureau of this Department.

CONDITIONS GOVERNING THE MAKING OF CROP REPORTS.

Various conditions govern the making of reports which influence the prices of farm products. Government crop reports deal mainly with products which are not quickly perishable. The prices of these are fixed at frequent intervals—often daily—by large market organizations, which gather information from the entire area as to the probable amount of products available, positions of any of the products on the routes of commercial movement, and the demand for the products. About these markets there are agencies which may combine to raise or lower prices artificially and temporarily, often so manipulating the prices as to destroy the needed confidence in merchandising the products, and resulting in unwarrantably large "handling charges" from the time the products leave the producer till they reach the consumer.

The producer should have as good a central crop-reporting agency as the buyer. Since his business is divided into many small noncooperative units, he can not have this without Government aid. The manufacturer, the dealer in actual products, and the consumer also need protection from the speculative manipulation of agencies organized to modify prices temporarily for their own advantage, and the main purpose of crop reports is that the whole people may be benefited by a knowledge of the actual facts which may influence current prices.

A knowledge which covers only parts of the area of a given crop may be misleading, because to judge for the entire area from conditions in some localities may give wrong results; hence the producer and others interested need a knowledge of the crop of the entire area expressed as a total. Reports covering part of an area, or covering the area definitely only in parts, may be used by self-interested crop reporting agencies to mislead. The reporting agency, in order to enable those interested as producers, consumers, or dealers to recognize the conditions in the entire crop area, must resolve all the facts into quantitative statements, preferably a single numerical statement,

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as of yield for the entire area, and the market must then resolve the balances between supply and demand into current prices. Only by "weighting" reports from each district, that is, by giving to each partial report only that arithmetical weight which the acreage in the area covered by the partial report demands and assembling the whole into one statement, can the crop estimator accurately report for the whole area. Such definite forms of statement have the advantage of placing the reporting agency under responsibility to attain accuracy, also of being easily interpreted by all parties; and they are capable of comparison from month to month or from year to year or with averages, as for the previous ten years.

The Bureau of Statistics, acting as a disinterested agency, has assumed the task of keeping the farmers, the dealers, and the users of farm products informed, and the general acceptance of its estimates in deciding prices is the only proof needed to establish the reasonable accuracy of these estimates. Its reports of conditions and its estimates used by markets in establishing current prices have become a necessary part of our domestic trade and our foreign business. These monthly reports serve as guides to all intermediate reports from whatever source, which without this monthly basis would be too local and partial to be of much value, and enable producers to know the facts as to the promise of prices for their crops, that false reports—which were common before the Government arranged to give the facts as nearly as they could be ascertained—may not mislead them into early sales at prices purposely made too low.

METHODS OF CROP REPORTING.

The Bureau of Statistics issues each month detailed reports relating to agricultural conditions throughout the United States, the data upon which these statements are based being obtained through a special field service, a corps of State statistical agents, and through a very large body of voluntary correspondents composed of the following classes: County correspondents, township correspondents, individual farmers, and special cotton correspondents.

A special field service is composed of ten traveling agents, each assigned to report for a given group of States. These are especially qualified by statistical training and practical knowledge of the crops. They systematically travel over the districts assigned them, carefully note the development of each crop, and keep in close touch with best-informed opinion; and they render written and telegraphic reports monthly and at such other times as required.

The State statistical agents are paid agents located in 43 of the States. Each of these reports for his State and maintains a corps of correspondents entirely independent of those reporting directly to the Department at Washington. These State statistical aids report each

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month directly to the State agent on schedules furnished them. Their reports are then tabulated and weighted according to the relative yield or area of the given crop in each county represented, and are summarized for the use of the State agent. Then he coordinates and analyzes them in the light of his own knowledge of conditions derived from personal observation and other sources, and prepares his monthly and other written and telegraphic reports to the Department.

There are in the United States approximately 2,700 counties of agricultural importance. In each of these counties the Department has a county correspondent, who maintains an organization of several assistants. These county correspondents are selected with especial reference to their qualifications, and constitute an efficient branch of the crop-reporting service. They make the county the geographical unit of their reports, and after obtaining data each month from their assistants and supplementing this with information obtained from their own observation and knowledge they report directly to the Department at Washington.

In the townships and voting precincts in the United States in which farming operations are extensively carried on the Department has township correspondents, who make the township or precinct the basis of the reports which they send directly to the Bureau of Statistics each month.

Finally, at the end of the growing season a large number of individual farmers and planters report on the results of their own individual farming operations during the year.

With regard to cotton, the information secured from all the foregoing sources is supplemented by that furnished by special cotton correspondents, embracing a large number of persons intimately concerned in the cotton industry.

SCOPE OF CROP REPORTS.

Eleven reports on the principal crops are received yearly from each of the special field agents, State statistical agents, county correspondents, and township correspondents, and one report relating to the acreage and production of general crops is received during the year from individual farmers.

Six special cotton reports are received during the growing season from the special field agents, from the State statistical agents, from the county correspondents, and from township correspondents; and the first and last of these reports are supplemented by returns from individual farmers, special correspondents, and a list of cotton ginners supplied through the courtesy of the Census Bureau, Department of Commerce and Labor.

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HANDLING THE CROP REPORTS.

It has been found necessary during the past year to thoroughly recast our methods of handling the crop reports. A gross breach of trust on the part of one of the responsible employees of the Bureau of Statistics, involving the misuse for private gain of the confidential reports to which this person had access, revealed a weak link in the chain. An entirely new method of handling the reports was devised, which it is believed makes it practically impossible for such a breach of confidence to occur in the future.

In the case referred to the prompt dismissal of the culpable official was followed by the submission to the Department of Justice of the whole matter, with a view to the prosecution of the guilty party or parties. It has thus passed beyond the jurisdiction of this Department. It is hoped that the law will be found adequate to reach this class of offenders.

This Department acted with vigor and dispatch when it got evidence of wrongdoing on the part of its own officials, but we have no evidence of disciplinary or preventive action at the traders' end of the line, where gamblers interested neither in production nor consumption disturb values to the injury of both, and make loud outcry when creatures of their own kind corrupt officials to betray confidence for the love of money. The responsibility for this "leak" is shared by everyone who, to get money without work, gambles in farm products. When this form of industry ceases these parasites who tempt Department officials will have to work for their bread.

METHOD OF PREPARING REPORTS.

For the purpose of checking up the results of the several sources of information and reducing the possibility of error to a minimum, the final results are made up by a crop-reporting board composed of the Chief Statistician or Chief of the Bureau of Statistics, as chairman, and four individual members, selected from statisticians and officials in the Bureau and members of the special field service called to Washington on report days for that purpose. Thus the plan is to select this board of four members each report day from an available corps of six or eight men well trained and thoroughly informed as to crop conditions and as to the relative value and correctness of the reports from the different corps of correspondents. This board, with several expert computers, meets on report days in the office of the Statistician under the personal supervision of the Secretary or the Assistant Secretary.

After the assembling of the board all reports by States from the several distinct corps of correspondents are brought together in convenient form in parallel columns on final tabulation slips, and the board is thus provided with several separate estimates covering

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the same territory and the same crops, made by the respective corps of correspondents, each reporting for a territory with which he is thoroughly familiar. There are also prepared for the board abstracts of the reports on each crop by States from the weekly weather-crop bulletins of the Weather Bureau, issued during the month. With all these data before them each individual member of the board computes separately his own estimate of each crop by States. These reports are then compared and discussed by the board under the supervision of the chairman, and the final figures by States are decided upon. It is interesting to remark how often the reports from the different corps of correspondents are very nearly identical and how often the final figures arrived at by the individual members of the board agree with each other. These State estimates, which are in percentages, are then multiplied into the acreages for their respective States. The sum of these products is divided by the sum of the acreages giving the percentage for the entire crop for the United States.

METHOD OF ISSUING REPORTS.

Reports in relation to cotton thus prepared by the crop-reporting board are issued on the 3d of each month during the growing season, and reports relating to the principal farm crops and live stock are prepared and made public on the 10th day of each month. In order that the information contained in these reports may be made available simultaneously throughout the entire United States, and that one part of the country may not have the advantage over another, they are simultaneously handed, at a given hour—as at 12 o'clock noon or 4 o'clock p. m.—on report days, to all applicants and to the Western Union Telegraph Company and the Postal Telegraph Cable Company for transmission to the exchanges and to the press. A mimeograph statement also containing such estimates of condition or actual production, together with the corresponding estimates of former years, for comparative purposes, is prepared and sent to a mailing list of exchanges, newspaper publications, and individuals. The same afternoon printed cards containing the essential facts concerning the most important crops of the report are mailed to the 77,000 post-offices throughout the United States for public display, thus placing the most available information within the farmers' immediate reach.

Promptly after the issuing of the report it, together with other statistical information of value to the farmer and the country at large, is published in the "Crop Reporter," an eight-page publication of the Bureau of Statistics, under the authority of the Secretary of Agriculture. An edition of over 100,000 of this Reporter is distributed to the correspondents and other interested parties throughout the United States each month.

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CHANGE IN METHODS.

A very great improvement has been made in the special field service by districting the United States and assigning each of the field agents to a definite group of States, which they thoroughly travel over and report on each month. The cotton-producing States have thus been redistricted and the service augmented and perfected there by the appointment of two new agents, men widely recognized as having a thorough knowledge of conditions and of the highest ability and integrity. A special agent has also been appointed for the collection of statistics of tobacco and has entered upon his duties of supplementing the reports from the Bureau correspondents by actual observation in the field. The work of the State statistical agents also is being improved.

Working in harmony and cooperation with the Census Bureau of the Department of Commerce and Labor, the compilation of statistics of the commercial cotton crop has been transferred to the Census Office.

The resignation of Mr. John Hyde as Statistician was accepted, and pending the permanent appointment of a successor to that important office Assistant Secretary Hays was directed to take charge of the Bureau.

FOREIGN MARKETS.

Required by law to collect and disseminate information concerning the exporting of the surplus of farm and forest above the requirements of domestic consumption, and concerning the preparation of such products to meet the special requirements of the various foreign markets, the Division of Foreign Markets of this Bureau has been of much service to the producers and the handlers of the agricultural surplus of this country.

DETAILS OF EXPORTS AND IMPORTS.

The base of the work done is necessarily the assembling and suitable treatment of the statistics of the foreign trade of this country in the products of farm and forest, and this work has been done in the most comprehensive way and with all available detail.

During the past eight years special examination has been given to certain classes of exports. The increasing restrictions of importing countries against the admittance of packing-house products and live meat animals have impelled cattle growing and slaughtering interests to request the aid of this Division; and in partial compliance with this request a complete statement has been prepared to show the extent and directions of this export trade during the last fifteen years.

So many inquiries have been received concerning various features of the exports of agricultural products during a long period of years

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that a report has been prepared and published covering the exports as far back as 1851.

Closely related to the disposal of the agricultural surplus is the subject of agricultural imports, and all necessary consideration has been given to this subject, besides utilizing current information. A compilation has been completed covering the last half century of these imports.

Within the last three years more particular attention has been given to the trade of the United States proper with its noncontiguous possessions, in the products of farm and forest.

BALANCE OF TRADE.

A new feature of the examination of statistics of exports and imports of agricultural products is the presentation of the foreign balance of trade in these products for a long series of years. This had not been done by any public office or private individual, and the importance of the matter at once appeared when it was discovered that the great balances of trade in favor of this country have been mostly, if not entirely, because of the products of the farm, which have often been called upon to offset adverse balances in manufactures.

FOREST PRODUCTS.

Particular attention was devoted three years ago to the foreign trade of this country in forest products, and this subject has been one in which current information has since been especially utilized. Statistics in detail of the entire foreign trade in forest products, including both exports and imports, have been compiled for a period of half a century.

EXAMINATION OF COMPETING COUNTRIES.

One of the most useful lines of investigation in behalf of exporters has been an examination of the conditions found in countries which have a surplus in certain agricultural products which meet those of this country in common markets.

General agricultural and industrial conditions have been the subjects of inquiry with regard to Norway, Sweden, Denmark, Spain, Scandinavia, Porto Rico, and the Philippine Islands during the past eight years.

A somewhat allied and more useful and important work has been undertaken with the object of ascertaining in detail the quantities and values of all the agricultural imports of the countries which receive a large share of such imports from the United States, as, for instance, the United Kingdom, Germany, and the Netherlands.

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WHEAT AS A WORLD PROBLEM.

Besides such investigations as the foregoing of general trade competition in certain markets, special investigations have been conducted concerning particular products. Wheat is one of these. A special agent of the Department spent over a year in Argentina collecting information concerning the production and marketing of wheat, among other subjects of inquiry.

Wheat again has afforded a special study of its production and prospects in Russia; and, as an important part of the cereal problem of the world, compendious facts concerning the production of cereals in principal European countries have undergone suitable assimilation for public uses.

Sugar is another product of international concern, and information covering the more important economic features of both beet and cane sugar production has received a clear and ample, although compact, presentation in a bulletin prepared in this Division.

PROBLEMS OF COTTON COMPETITION.

Within very recent years no agricultural product has given to the world as great a problem as cotton, and on this account cotton production, actual and potential, in all of the countries where such production is possible, has received a searching examination. The inquiries made with regard to prospective cotton-growing competition have not so far discovered that it has any reasonable immediate prospects, but rather indicates that if such competition is to arise it will be in consequence of years of effort and development. Besides this, it appears that nearly all regions where new production is attempted for commercial purposes produce a cotton like the Egyptian.

DAIRY PRODUCTS.

The low position occupied by the dairy products of this country in principal European markets has excited comment, and the weakness of their representation in foreign trade statistics has led to a special examination of this subject by an agent who has spent several years in England.

PACKING-HOUSE EXPORTS.

In connection with other work done in the interests of cattle growers and meat packers, particular attention has recently been given to all of the principal countries of the world which have a surplus of these products of the farm or ranch for export.

The principal countries of Europe that import packing-house products have afforded a field for a full investigation concerning the kinds, quantities, and values of such products as enter these countries.

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together with sources of such imports among the various exporting countries of the world.

TARIFF LIMITATIONS.

In every consideration of an export problem it may be and often is essential that the foreign tariff shall be ascertained and made understandable to the public. Work of this sort has been carried on during the past few years upon a large scale and has embraced the translation and elucidation of all the tariffs of the world governing the importation of packing-house products, of grain and grain products, and of fruits and nuts. A more particular study has been given to packing-house products than to any other.

TRANSPORTATION OF EXPORTS.

Transportation is a prominent subject with which the attention of this Division has been occupied within half a dozen years. The object is to provide the public with useful information concerning the routes over which the surplus products of the farm go to ports for transportation by water to foreign markets; to explain the methods by which shipments are made; to make known the equipment of the various ports for handling export business; to ascertain and make known the rates charged by railroads for moving freight of this sort; and also to ascertain for the service of exporters what lines of steamships are in regular operation, to what ports they carry freight, and what the charges are for various descriptions of farm products.

RESIDENT LONDON AGENT.

This Department maintains a special agent in London for the purpose of being in closer touch with Old World markets and information, and has done so for the past four years. Besides reporting the crop news of other countries he is engaged from time to time upon special inquiries which are of practical concern to producers and exporters in this country.

GROWING SPECIAL SERVICES.

Along with numerous special lines of work carried on and developed within the Bureau has grown a correspondence with persons in all parts of this country who are in pursuit of special information, and in this way a public service has developed which has assumed proportions of considerable size and of increasing utility.

THE LIBRARY.

For the advancement of work in the Department all important publications relating to agriculture and to the sciences upon which it is based are necessary. General treatises, technical monographs, and new scientific periodicals must be available as laboratory tools for the

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up-to-date investigators in agricultural science. Over 4,000 such books and pamphlets, including publications of scientific societies, have been added to the Department library during the past year. This growth has been steadily maintained for the past ten years, resulting in a collection of works relative to agriculture, agricultural education and research, as well as the kindred sciences not elsewhere to be found in the country. The collections of works relating to special sciences such as economic entomology, zoology, veterinary science, and botany are of exceptional excellence, both as to size and the number of valuable books of early and late dates.

To facilitate the use of this valuable material, card catalogues, reference lists, and bulletins are maintained and kept as nearly up-to-date as possible.

The present quarters are inadequate for housing this collection of 87,000 books and pamphlets and insufficient in the accommodations for readers and the staff in charge of these books. In addition to space for this valuable possession of the Department, the protection of a fireproof building is most urgent. Such protection, however, will soon be provided by the new Department building.

The resources of the Library are not only made available to scientists at a distance through the system of interlibrary loans, whenever it is possible to do so without interference with the work of the Department, but information is also constantly forwarded in response to letters from all parts of the country. The reference work of the Library has more than doubled in this direction during the past two years as the facilities for meeting the demands have increased.

The publication of a quarterly bulletin of accessions, which is a representative list of current agricultural literature, and of the index cards to the Department publications has been continued. The latter publication, numbering upward of five thousand cards, is of especial value to agricultural colleges, experiment stations, public libraries, and libraries of institutions receiving the Department publications. These cards furnish a permanent index which can be incorporated with the public card catalogue of any library.

The wide distribution of our publications, especially to institutions and scientific societies in this country and abroad and to foreign governments, has resulted in the receipt of a very large number of transactions, periodicals, and foreign documents, which have added much valuable material to the files of periodicals and other serials in the Library. India, Japan, Australia, and Africa, together with other less remote countries, have generously contributed reports of their work in agriculture in exchange for the printed results of work done by the Department. The foreign mailing lists of the Department being in charge of the Librarian, a system of exchanges is thus maintained which is of great benefit to the Library.

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OFFICE OF PUBLIC ROADS.

Probably no field of work is of greater interest to the public at large than the improvement of our highways. The Office of Public Roads, as now constituted, represents a distinct stage in the development of the work undertaken by the Federal Government in 1893 by the establishment of the Office of Road Inquiry. At the time of the establishment of the Office, the lack of a knowledge of existing conditions was a serious hindrance to an intelligent application of any plan for road improvement. The name originally chosen for the Office was suggestive of the purpose of Congress, which was to inquire into systems of road management throughout the United States, and into methods of road making, and to disseminate information as to the results of such inquiries.

The most important result which has been attained up to this time, whether produced by influence in or outside of the Office of Public Road Inquiries, is that the people in all parts of the country are now interested in the subject of road improvement, and are seeking such information as will enable them to carry on the work along intelligent lines. It was found, therefore, that the collection of information must of necessity become only one feature of the work of the Office, and that facilities must be provided for answering as well as awakening inquiries. At the same time the necessity for demonstrating scientific and economical methods of road construction instead of mere agitation has been clearly established.

EXPERT ADVICE AND OBJECT-LESSON ROAD WORK.

The work of the Office is primarily educational in character. Its province is to detail engineers and experts to give information and advice. Whenever there is any question as to what road material is best suited for the local conditions, samples of all the available materials may be sent to the laboratory of the Office, where tests will be made to determine the selection of the best material. In the majority of cases the detail of an engineer or expert to make a preliminary investigation and give advice is all that is required. There are, however, communities where it has been found advisable to supplement advice by a practical demonstration of effective road building.

OBJECT-LESSON ROADS.

To meet this need the object-lesson method was adopted on the following plan: A section of road is selected for improvement, and after the proper surveys and estimates have been made by an engineer of the Office, expert foremen and machinery operators are sent out in charge of modern road-building machinery, and the local officials are taught by actual demonstration every step in the proper construction

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of a road. Absolutely no expense is incurred by the Federal Government in this work except for the salaries and expenses of the Government employees, the local communities being required to furnish the right of way, all common labor, teams, materials, etc., used in the work.

The total number of experimental and object-lesson roads built under the direction of the Office since its organization is 96, with a total length of about 39 miles. The roads were built in 28 States, the materials used in construction being shells, gravel, brick, oil, tar, sand-clay, marl, stone, burned clay, slag, and steel track.

Four complete road-building outfits were placed in the field at the beginning of the past fiscal year, and their work has continued without interruption. Twenty-one sections of road have been built during the year in nine States, the total length being a little over 9 miles. In the construction of these roads a variety of materials was used, such as stone, shale, burnt clay, sand-clay, shells, gravel, and marl. The detailed reports submitted by the engineers in charge of work show a maximum cost of 98 cents and an average cost of 55 cents per square yard for macadam roads, while the average cost of sand-clay roads is shown to be 9½ cents. The only burnt clay road constructed was built at a cost of 20 cents per square yard.

In the work done under Government direction there was of necessity a great variation in cost on account of the difference in cost of labor and teaming, amount of grading required, length of haul, and general efficiency of labor.

Since the passage of the act of Congress approved March 3, 1905, creating the Office of Public Roads, steps have been taken to place the field work on a more systematic and businesslike basis than heretofore. This has been to some extent accomplished by increasing the force of engineers and experts and decreasing the number of men detailed as public speakers and lecturers.

A circular of instruction defining object-lesson road work and expert advice within the meaning of the act of Congress, and setting forth the terms under which this Office is prepared to grant assistance is sent out in answer to inquiries on the subject. A blank form of application for expert advice and assistance has been prepared, which is required in every instance to be filled out and signed by the local authorities.

The construction work is at present under the management of trained engineers, who are assisted by experts qualified to operate all road-building machinery. When an object-lesson or experimental road is to be built, complete surveys, plans, specifications, and estimates are prepared and the fullest preliminary information is obtained.

As far as practicable itineraries are made up for each party in the field, covering a considerable period of time, in order that the greatest

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amount of work may be accomplished with the least expenditure of time and money. The work is planned so that it may be carried on in the North in summer and in the South in winter, thus avoiding interruption as much as possible.

There appears to be a growing need for the construction and maintenance of roads in the forest reserves. In view of the fact that the Office is maintaining a gradually increasing corps of competent highway engineers and experts, it would seem to be a wise arrangement to utilize the services of these men, wherever practicable, in the construction and maintenance of roads in the forest reserves and other areas which are now or which may hereafter come under Government control.

Heretofore machinery has been borrowed from the manufacturers who have been willing to lend it for the construction of the object-lesson roads. Transportation for men and machinery has usually been secured free of charge from the railroad companies, who have generally shown themselves ready to cooperate on the ground that improved highways directly benefit them. The practice of borrowing machinery and of depending upon free transportation is not, however, the best policy. Gratuitous assistance inevitably tends to hamper that freedom of action on the part of the beneficiary which is essential to the proper performance of the work intrusted to public officials. A plan for leasing machinery at a certain per cent per annum of the list price is being favorably considered, and, if the request for an additional appropriation to make this arrangement possible is granted, it is probable that ten outfits of machinery will be secured and placed in the field. It has been ascertained that this plan is perfectly feasible, and that the machinery can be secured at a fair and reasonable rental. Should the recommendation in regard to an appropriation to cover freight charges meet with approval the old practice of free transportation will be abolished.

EXPERIMENTAL FIELD WORK.

There are vast areas in the country in which stone is not available for road making, and in only a few localities has it been found practicable to overcome the difficulty, on account of the cost of transportation. In such cases the problem is how to obtain a suitable substitute. In some sections of the South roads have been built of mixtures of sand and clay. These roads have generally proved satisfactory, and the efforts of the Office have been directed toward originating special methods for putting such materials to use.

In the great Mississippi Delta the use of burned clay or gumbo has been introduced, under the direction of the Office, with what would seem to be marked success. This is shown by the results obtained on

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an experimental burned-clay road constructed at Clarksdale, Miss. Previous to the construction of this road experiments had been made in the laboratory of the Office to determine the best method of burning the clay. This experiment may possibly prove of value to other parts of the country, for instance, in many of the prairie States, in which no other form of road-building material is available. The report from the South on this special form of construction has been most encouraging, one county alone having appropriated $25,000 to be expended principally in this way in the immediate future. Roads of this nature are said to be more economical, efficient, and lasting than gravel roads which have been constructed in the same section.

In addition to the study of the various methods of construction and their application to those large sections of the country which at present enjoy few if any improved roads, considerable attention has been given to problems in the maintenance of roads. These have particularly to do with the suppression of dust, which has already become in some localities such a nuisance as to warrant considerable expenditure for its cessation. This is a question that has already received the attention of the French Government road engineers, as well as those in England and elsewhere, for the past seven or eight years. It is now occupying the attention of highway engineers in this country.

A treatment which will retain the dust on the surface of a macadam or gravel road is of special value at present, owing to the great damage done to such roads by motor-car traffic, which has the effect of loosening the dust to such an extent as to seriously damage the road.

Extensive experiments for laying dust by the application of oil and coal tar on macadam and earth road surfaces have been conducted by this Office during the past year at Jackson, Tenn., and it is hoped that the data and information to be obtained from these experiments will be of great interest and value. In this connection it might be mentioned that perhaps more inquiries are received concerning the use of oil and tar than on any other phase of the work of this Office. At present there exist little or no exact data on this subject, but it is believed that the experiments referred to will in a great measure answer many of the questions that are now in doubt.

There are at present a number of patented solutions which are recommended to lay the dust on roads more effectively and economically than water sprinkling. It is expected that investigations will be carried on in the laboratory of this Office to ascertain the relative effect of various chemicals which may be used in sprinkling streets and roads.

INSTRUCTION IN HIGHWAY ENGINEERING.

In order to secure engineers having the necessary technical training as a basis, and to supplement such training by special work in highway engineering under the direction of the Office, the plan has been adopted

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of appointing graduates of reputable engineering colleges to the position of civil engineer student in the Office of Public Roads. These young men are required to pass rigid competitive examinations before entering the service and receive practical and scientific instruction and work for the period of one year, this being in the nature of a graduate course in highway engineering. At the end of that time they are given a certificate in the nature of a diploma, and may be retained in the service without further examination.

The work of these students includes personal inspection and reports in detail of the methods of construction carried on by different State highway commissions in the States where such work has been systematized and put upon a practical basis. They are also required to make surveys and estimates of the actual cost of building roads under various local conditions. Thorough training in methods of testing the various qualities of road materials is acquired by actual work in the laboratory, so that the value of the different physical properties of the materials may be made clear to them. The work of these engineer students is of great assistance to the Office, in addition to being of much practical value to the public at large.

It is of the utmost importance that the great sums of money appropriated for road improvement throughout the country should be expended wisely, under the direction of properly qualified men. At the present time the number of trained highway engineers is entirely inadequate to meet the demand. It will be of inestimable value to the public if the Office can provide even a few such men each year.

Instruction in highway engineering in schools and colleges throughout the country should receive greater attention at the present time, owing to the rapid development of road building. The Office, so far as its limited facilities permit, will cooperate with the various educational institutions in placing this branch of education on an adequate basis and in inaugurating highway work.

TESTING OF MATERIALS AND SPECIAL INVESTIGATIONS.

One very important feature of the development of the work of the Office has been the testing of materials available for roads in different parts of the country and the investigation of special qualities which are necessary if the most successful results are to be obtained. A large number of tests have been made on all the different kinds of materials which are in use in the construction of highways, and in addition to these routine tests a number of important and valuable investigations have been carried on. By far the greater number of tests have been made for the benefit of State and municipal authorities who have evinced a desire to obtain accurate data to enable them to make a careful and wise selection of the best material at hand. The best indication of the importance of this work is shown by the fact that many of

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the State governments are establishing laboratories and conducting work along the same general lines that have been followed in the laboratory here.

The equipment of machinery necessary for testing road materials is also available for testing other materials of construction relating to agriculture, and thus duplication of equipment is avoided by extending the scope of the work of the Division of Tests. It has been possible to undertake several investigations which bear directly upon problems that the farmers of the country have to face.

For some time past numerous complaints from a variety of sources have reached the Department concerning the inferior lasting quality of the steel-wire fencing offered in the market at the present time. Preliminary inquiry showed that these claims were well founded, and a thorough investigation was ordered. Enough has already been accomplished to show that the farmers will derive great benefit from this work.

The interest of manufacturers has been aroused to the extreme importance of this matter, and measures are already being taken in many of the leading manufactories to bring about an improvement in the conditions complained of. When it is considered that much of the wire which was produced thirty years ago is still in good condition, whereas the life of wire put on the market in more recent years is often not longer than two to seven years, the money saving to the farmers of the country that will be brought about by the improvement in present conditions becomes apparent.

The fact that in many parts of the country it is difficult to procure wood for fence posts, added to the fact that wooden posts rapidly decay, has stimulated the desire to present the farmers with simple information and directions that will enable them to make use of reinforced concrete. Reinforced-concrete fence posts of various types have been made in the laboratories and tested.

One of the most important qualities possessed by rocks which render them useful for macadam-road building is that of binding power. A study of this important quality has been one of the principal subjects of investigation by the Division of Tests, and several valuable bulletins have been published setting forth the results obtained. In the course of this work it was observed that when some rocks are ground to very fine powders they undergo certain decompositions, owing to the action of water. In view of the fact that many of our large rock deposits are rich in potash, and in view of the extent to which these decompositions are found to take place, it becomes apparent that if the rocks are subjected to a process of fine grinding it is possible that they may be directly available as fertilizers.

The importance of this subject of investigation can not be overestimated, when it is considered that no original source of potash exists

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in this country to-day and that we are entirely dependent upon foreign sources of supply for all the potash used annually by our farmers and growers. The further investigation of the possible source of supply will be vigorously pushed in the various bureaus of the Department which are especially equipped for carrying on work of this nature. Under the stimulus of the cement industry, which has grown to enormous proportions in this country, the development of machinery for grinding rock to fine powders has made rapid strides within the past few years, and it is now possible to consider the feasibility, from an economic standpoint, of grinding material which a few years ago would have been out of the question.

In view of the growing importance of the cement industry to-day it is necessary to prosecute studies and inquiries into the actual constituents and character of Portland cement, and to this end an agent of the Office was assigned to work on this subject.

It is proposed during the next fiscal year to carry out investigations along the same general lines, adding from time to time other problems of a similar nature in so far as time and equipment will permit.

COLLECTION OF INFORMATION.

While it is known in a general way that some parts of the country have progressed much further than others in the matter of road improvement, there is little available information regarding what has been accomplished in the various States and counties. If comprehensive statistics were available it would be shown that large sums of money are annually wasted in some sections, while in others surprisingly satisfactory results are obtained at a moderate cost. The Office is now collecting information from every county in the United States in regard to the mileage of improved and unimproved roads, the amount of cash tax, bonds issued, and other information of a similar nature. No more telling argument for reform in wasteful methods can be adduced than to bring home to every county just what results they are obtaining as compared with the results obtained by other counties at a similar cost. This information, which is now being compiled, will be published for each State as soon as completed.

CONVENTIONS.

Government participation in road conventions and the organization of road associations has been considerably curtailed during the past year. Such participation does not seem to be justified when the sole object of the meeting is agitation for the purpose of influencing legislation. Aside from the propriety of the case the results achieved through speeches by Government employees at popular gatherings of this character can scarcely be considered as having a marked influence upon the progress of road improvement in the United States.

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There is, however, a field of real usefulness to be reached by means of speakers and lecturers of the Office. Road organizations serve a useful purpose in arousing the people to a realization of the need for better roads. The problem that is most serious to rural communities, and one which it should be the province of specially equipped employees to explain at meetings of local officers and taxpayers, is what they need, how to go about getting it, and what their roads will cost. These speakers should be so well equipped that they can give definite and concise information, on which the local committees may act with safety.

Another branch of this work capable of beneficial results is a cooperative system of lectures in engineering schools throughout the country. As already stated, the demand for skilled highway engineers is already in excess of the supply and the educational institutions of the country should take prompt and adequate steps to meet the situation. Aside from the engineering features, there are many economic questions involved that should be brought out in lectures to students who intend to devote their lives to highway work.

Much of the work embraced in the scope of the Office is of a scientific and technical nature and involves original thought and investigation. Papers should be prepared and read at the meetings of scientific bodies, and properly qualified members of the Office should keep in touch with organizations having under consideration matters bearing in any way upon the purposes for which the Office was established.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH AGRICULTURAL EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has greatly increased during the past eight years, partly by the extension of its business along lines previously established and partly by the addition of new functions. The Office was established to be a clearing house for the agricultural experiment stations organized under the act of Congress of 1887, and as such it has accomplished much valuable service. This Office is charged with the supervision of the Federal funds granted to the experiment stations and issues a considerable number of publications based on their work. The policy has been to make the supervision of these funds more strict and to insist on their application to agricultural research. The result is that the stations have been greatly strengthened as research departments of the agricultural colleges, and their experimental work has been so successful as to win the support of a very large constituency of intelligent farmers. The States have thus been led to supplement the funds granted to the stations by Congress, until now the annual resources of the stations from sources

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within the States are equal to those derived from the National Treasury. While many forces have contributed to this end, the influence of the Department is generally acknowledged as an important factor in determining the success and prosperity of the stations and in making our experiment-station system the strongest and most efficient in the world.

It is fitting in discussing the relations of the Department with the stations to call attention to the great influence the latter have had in bringing home to the people the results accomplished. Not only have the stations been a vital factor in making the Department's work more effective, but they have by their own investigations lifted American agriculture to a higher plane.

The Department is cooperating in many ways with practically all of the stations, and as time goes on this work is bound to increase. The stations have now reached a critical point in their development, and they need and will receive all the assistance the Department can give them. In the increasing demand for more light on agricultural practices and the growing interest in rural life generally, the stations must have the means for meeting these demands. It is hoped that Congress will recognize this need, as it is already being recognized by some of the States themselves. There is no direction in which public moneys can be appropriated that will bring more certain and lasting returns than in helping the State experiment stations to do more research work.

The close relations which the Department has held with the stations in recent years has naturally led to a great increase in the number and extent of the enterprises in which the Department and stations have cooperated. By this means the range and effectiveness of many agricultural investigations have been enlarged, and it has been possible to bring the Department's work into vital touch with agricultural industries and agricultural people.

An effort has also been made to perfect and increase the technical publications of this Office in order to thoroughly acquaint investigators of agricultural problems in this Department, the experiment stations, and elsewhere in the United States with the methods and results of such investigations the world over. For this purpose the scope and thoroughness of the review of the literature of agricultural science made each month in the Experiment Station Record have been greatly increased. It may be conservatively asserted that no similar journal approaches it in comprehensiveness within its peculiar field.

The combined index of the first twelve volumes of the Record, with more than 125,000 entries, is a complete key to the literature of agricultural science from 1888 to 1901. The card index of experiment-station literature, now including 26,000 cards, also furnishes a ready means of ascertaining what our stations have done in any line, and is especially useful to agricultural students.

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In order to diffuse the results obtained by the stations in the several States among the farmers throughout the country, this Office was directed to undertake the publication of a series of popular résumés of practical features of the stations' work, under the title of Experiment Station Work. Over thirty numbers of this publication have been issued in the general Farmers' Bulletin series, and have had a wide distribution.

PROMOTION OF AGRICULTURAL EDUCATION.

The period covered in this review has witnessed very great activity in the development of agricultural education by the reduction to pedagogical form of the great mass of educational material accumulated by this Department, the experiment stations, and similar agencies in many countries; by the enlargement and better organization of agricultural faculties in our colleges; by the providing of more adequate buildings, apparatus, illustrative material, and other equipment for agricultural instruction, and by the extension of agricultural courses to the lower schools.

The Department has been active in promoting this educational development in various ways, and the Office of Experiment Stations, through its intimate relations with the agricultural colleges, has naturally taken a leading part in this work.

Since the permanent success of agriculture depends on the intelligence and technical knowledge of the farmers, the Department can engage in no more important work than to aid in arousing agricultural people to a keen sense of the importance of establishing in this country a system of public education which will make men and women not only intelligent citizens but also efficient and successful workers in agriculture and the other industries which must ever engage the attention of the great mass of the population. This Department and the experiment stations are largely engaged in gathering the materials which will constitute the future of education in agriculture, and the permanent impression which their work will make on agricultural practice will be largely determined by their success in incorporating the results which they obtain in courses of instruction to be given the youth in agricultural colleges and schools. The Office of Experiment Stations has been encouraged to ally itself as closely as possible with the movement for the extension of agricultural education among the colleges and in the public schools, and the Department will this year recommend to Congress that provision be made for a more active propaganda by this Office in the interests of agricultural education, for it is certain that active work in this direction will produce far-reaching results in the near future.

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AID TO FARMERS' INSTITUTES.

Recent years have also witnessed the development of a great system of popular agricultural education for the adult farmer through the farmers' institutes which are now held throughout the country and annually attended by about a million men and women engaged in agricultural pursuits. With the growth of the research work of this Department and the experiment stations it has become very evident that publications alone would not meet the demand for information regarding improved methods of agriculture and the ways in which the results of scientific investigation may be applied to agricultural practice. The absence of agricultural instruction in the schools and the coming on to the farms of millions of people from foreign lands, together with the widespread interest in the results of agricultural research, have made it necessary that means be devised for giving agricultural people instruction by word of mouth which will enable them to understand and utilize the information so largely given out in the publications of this Department and the stations.

For this purpose the farmers' institutes established under public authority in the States and Territories furnish an agency of great usefulness. It has therefore seemed highly desirable that this Department should ally itself closely with the farmers' institutes, and make them efficient instruments for the wide diffusion of the knowledge gained by the Department and other agencies for agricultural research. With this end in view a farmers' institute specialist was appointed two years ago in the Office of Experiment Stations, and efforts have been made to place at the disposal of the institute lecturers the information gained by the Department in many lines.

ESTABLISHMENT AND PROGRESS OF EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

Under various acts of Congress provision was made for agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and the stations were established in Alaska in 1898 and in Hawaii and Porto Rico in 1901. Their administrative control was placed in the Office of Experiment Stations, and a Division of Insular Stations was created.

The headquarters of the Alaska stations were established at Sitka, and branch stations were undertaken at Kenai, Copper Center, and Rampart. In Alaska the first problem was the introduction of agriculture. With a few exceptions about some of the larger villages, little had been attempted in the way of gardening, and nothing done on an extensive scale. Much pioneer work in the way of clearing, fencing, building, etc., was necessary at all these places, but attention was given from the first to the introduction of varieties of economic plants that were thought promising for this country. When tried and

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found adapted to the prevailing conditions they were distributed as far as possible, and the settlers urged to take up their cultivation. For a time the principal investigations were with garden vegetables, and it has been demonstrated that the growing of hardy vegetables is possible over a great portion of Alaska as far north as the Arctic Circle. This has made possible a wide extension of gardening, and many villages owe their present supply of fresh vegetables to the demonstration of the experiment stations.

Cereal growing has also been taken up and found practicable away from the coast, rye, barley, and oats having matured every year at the Rampart Station, although situated at 65° 30′ north latitude. The climatic conditions at Sitka not warranting extensive experiments with cereals, horticultural crops of various kinds are being investigated, and nurseries of hardy fruits, berries, etc., have been established. In addition to introductions, experiments in plant breeding with native fruits are being carried on with promise of success. Soil studies made over large tracts have shown that the seemingly rich soils are peaty and often quite acid. Methods of treatment for correcting the faulty conditions have been found, and the station's results are being widely adopted. Experiments in animal husbandry and dairying have been begun and will be developed as the facilities of the stations will admit.

In Hawaii the station was located adjoining Honolulu, on a tract of land set aside for the purpose by the Territorial authorities. The work in Hawaii has been along the line of the development of agricultural industries, to supplement sugar-cane growing and to secure a greater diversification of crops. The station's experiments with tobacco, although only carried on for the past two years, seem to indicate that it is entirely feasible to grow a type of cigar tobacco but little, if any, inferior to the average product of Cuba. Previous experiments with tobacco had failed, but with attention to varieties, soils, curing, and fermentation a product was secured that was given high rank by experts. Successful efforts to introduce forage plants for the stock ranges have been noted in a number of instances, and a prominent stockman says the success along this one line is worth many times over what the station has cost. Through the station, bananas from Central America have been introduced to supplant the varieties in cultivation for markets of California, Oregon, Washington, etc. The local varieties do not bear shipping well and the Central American varieties are superior in this respect. An effort is being made to develop the growing of citrus fruits for local use, the supply now coming almost wholly from California. Investigations are being made of fungous and insect pests, soils, etc., and many matters of great importance have been discovered and the results given to the public.

The Porto Rico Station was first located on a tract of leased land near Rio Piedras, but after a year it was permanently established at

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Mayaguez, where a plantation of about 240 acres was furnished by the insular authorities. One of the chief problems in Porto Rico has been the introduction of improved methods of agricultural practice. To supply information along this line experiments have been inaugurated with nearly all agricultural and horticultural crops grown on the island, and also with others believed to be adapted to the conditions. It has been possible to suggest methods whereby increased production with several crops can be secured with but little more labor and expense than that usually given. Insect pests have been studied and means found for combating a number of the more destructive ones. Experiments with coffee have been in progress ever since the station was established, and trees under investigation yielded double the crop obtained from others in the same plantation. The means by which this result was obtained were pruning, cultivation, and fertilizing, and they may be readily followed by any grower. A large collection of economic tropical plants has been brought together, permitting a comparison of varieties, testing their adaptability, and making possible plant-breeding work on an extensive scale. Experiments with horses, cattle, and pigs have been begun and will be extended as opportunity offers. Other experiments under way are with leguminous plants for forage and rotation crops, rice growing, citrus and other fruits, vegetables, etc. The value of tile drainage has been shown by a demonstration on part of the station farm. This was the first piece of tile drain in Porto Rico, and its efficiency is well recognized.

All the insular stations cooperate in various ways with our Bureaus, giving a wider field to the investigations of the Department, while the stations receive the benefit of our more extensive resources. These stations are all becoming centers of information and demonstration in their several localities, and their power for good is already recognized.

PROGRESS IN NUTRITION INVESTIGATIONS.

The nutrition investigations have been conducted on a cooperative plan by which work has been undertaken in nineteen States and three Territories, in which the Department has been associated with experiment stations, agricultural colleges, universities, and other educational institutions, philanthropic associations, hospitals, and institutions for charity and correction. The Department funds have been supplemented in various ways, including the use of laboratories, apparatus, and the time of investigators, as well as by State appropriations and funds derived from other sources.

During the past eight years the work has developed very materially both in scope and in the importance of the results obtained. During this time some 200 dietary studies have been made and not far from 800 experiments in which the digestibility of different foods was deter-

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mined with healthy men under normal conditions. Over 70 experiments with the respiration calorimeter have been completed with 9 different subjects covering a period of two hundred and nine days, during which time the total income and outgo of both matter and energy have been measured and studied. Many experiments have also been made regarding the changes which take place when meat, vegetables, and flour and other cereal products are cooked in different ways, and considerable attention has been devoted to the compilation of the results of Department work, as well as that of other investigators. During the period under consideration some 45 technical bulletins and 26 Farmers' Bulletins and other popular summaries have been issued.

As the nutrition investigations have developed it has been found in the main desirable to concentrate resources upon several problems which have seemed of special importance and to cooperate with institutions where conditions were particularly favorable.

The experiments which have been carried on in California have demonstrated the fact that both fruits and nuts may furnish a considerable portion of the diet at a reasonable cost.

A large number of studies made at the Maine and Minnesota experiment stations have shown that, with all classes of wheat, white bread furnishes the body with more protein and energy, pound for pound, than whole wheat or Graham flour ground from the same lot of grain, since any deficiency in the composition of the white flour is more than offset by its more thorough digestion. Investigations with cereal breakfast foods have also shown that the different commercial brands differ little in real nutritive value, though they differ widely in cost and quite considerably in method of manufacture. The different kinds of bread have been shown to be wholesome and economical foods, and the same may be said of the standard breakfast foods, the use of different kinds of breads and breakfast foods being an easy way to secure that variety in the diet which is considered important as well as pleasing.

The Tennessee investigations have demonstrated that dried legumes (beans, peas, and cowpeas) are quite thoroughly digested and are economical sources of vegetable protein. The thoroughness with which they are assimilated depends in considerable degree upon the method of preparation, being greatest when the legumes are so thoroughly cooked that they are readily masticated and thoroughly mixed with the digestive juices of the stomach and intestinal tract.

As shown by the investigations at the University of Illinois, the losses which meat sustains when cooked in hot water are greater than when dry heat is used, as in roasting or baking, though in all cases the losses of nutrients are small. Dry heat applied in different ways

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develops flavor to a greater extent than cooking in hot water. The different kinds and cuts of meat differ somewhat in the thoroughness with which they are digested, as do meats cooked in different ways. However, it may be said that meats as a class are very thoroughly assimilated by the average man under normal conditions.

The experiments carried on at Middletown, Conn., with the aid of the respiration calorimeter have furnished very accurate data regarding the actual energy requirements of the body, the relative energy production at work and at rest, sleeping and waking, and under other conditions; the normal variations in body temperature, effect of varying amounts of carbon dioxid and moisture in the air upon bodily comfort, the relation between food consumption and excretory products, and similar topics; they have also supplied valuable data for the discussion of problems of ventilation and hygiene. Recently, as a part of this work, very important and useful factors have been deduced with which it is possible to compute the carbon dioxid and energy output of man at rest and performing muscular work of different degrees of severity, and also the energy expended per day by men engaged in any one of the ordinary occupations or trades. When these quantities are known it is possible to form an estimate of the actual food requirements.

A résumé of the results of the nutrition investigations should take into account the extended use which has been made of the technical publications summarizing the results of the work, and also of the popular summaries which have been issued at frequent intervals. These publications are used as text-books in a large number of schools, colleges, and medical schools throughout the country and are widely read in American homes, as is shown by the constantly increasing demand for them. The very large correspondence of the Department regarding nutrition problems is another indication of the widespread popular interest in the work.

ESTABLISHMENT AND DEVELOPMENT OF IRRIGATION AND DRAINAGE INVESTIGATIONS.

In 1897 Congress appropriated $10,000 to enable this Department to investigate irrigation laws and irrigation practice. The present Irrigation and Drainage Investigations, for which $74,200 was appropriated in 1905, is the outgrowth of this initial appropriation. It was the beginning of systematic study by the General Government of the agricultural and legal features of irrigation—the two features which have a controlling influence on the peace and enduring prosperity of irrigated districts.

The need of more definite information on these subjects was shown in the wide discrepancy of view regarding the duty of water as exhibited in court decrees fixing water rights and in the water-right contracts of

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canal companies, the quantity allowed for the irrigation of an acre of land one year varying all the way from enough to cover it to a depth of 6 inches to enough to cover it to a depth of 500 feet. The value of these measurements of the duty of water has been shown in preventing decrees for excessive amounts of water and the chaos, injustice, and unending litigation which came from decisions and agreements which gave one man more than he could use profitably and another less than his crops required.

These measurements of the quantity of water used in ordinary practice have been followed by more careful experiments to determine the frequency of irrigation and the amount of water which should be applied at each irrigation in order to get the best results. The object of these investigations is to furnish the information needed to establish a proper system of rotation, prevent the injury of land by excessive use of water, and reduce to a minimum the losses from seepage and evaporation.

Accompanying the measurements of the duty of water have been measurements of the losses from seepage and evaporation in canals and ditches. These losses were far greater than had been commonly supposed, amounting in many instances to more than half the water turned in the head-gates.

The determination of seepage losses has been followed by experiments in the lining and puddling of ditches to lessen such losses, which have been an active agency in improving this feature of irrigation practice and increasing the service which streams will render. It has also retarded the extension of the area injured by seepage water and alkali.

An important feature of irrigation development in the United States is that each year thousands of acres of new land have to be cleared of brush, graded, and ditched for the distribution of water. Another fact is that much of this work is done by settlers to whom the whole subject of irrigation is strange and new. Nothing could have been more wasteful than to leave each of these beginners to find out for himself how to do this work, and the Department has rendered valuable aid by the publication of practical bulletins describing the tools and methods of clearing and grading land, giving the cost of this work, and explaining the methods of applying water suited to different soils, crops, and climates. The information given in these bulletins has been collected in widely separated sections of the country and includes practically every method of applying water to be found in this or any other irrigated country.

The studies of irrigation laws and irrigation institutions have included the collection of facts showing the character and amount of the water rights and the methods of their establishment in the different Western States. Having the facts before them, the people of those

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States have been able to determine what sort of legislation was required for their improvement, and it has been the policy of the Department to let these facts furnish their own argument, the Department confining itself to the statement of the general principles which should underlie the control and management of public water supplies. It is not possible to speak certainly regarding the influence which these investigations have exerted, but it is known that in the eight years since they were begun there has been a progressive interest in the reform of irrigation statutes and in the laws and customs which determine the relations of irrigators to each other. The facts presented in the official bulletins of this Department have been largely quoted and the laws enacted have been in harmony with the general policy advocated by this Department.

Irrigation and drainage are inseparable. In every irrigated district some lands have to be drained. Without this the soil water rises to the surface and renders the land unproductive from excess of water or alkali. The drainage investigation grew out of need for plans for removing the excess of water coming from seepage and waste on irrigated fields. It has been extended to embrace the entire country, where in many sections drainage is a fundamental necessity if the full productiveness of the soil is to be secured. The drainage problems which have been dealt with have included the preparation of plans and giving expert advice about large projects and the making of studies to determine the feasibility of drainage and the methods to be followed in many parts of the Mississippi Valley.

Experiments are also being made to determine how far drainage can be made to protect hillsides from the destructive effects of erosion. In the whole United States there are about 100,000,000 acres of swamped and overflowed lands which can be reclaimed only through drainage, which will change these from unhealthful and worthless areas into some of the most productive farm lands in the country.

To these two branches of rural engineering there was added last year the study of farm machinery and appliances used in agriculture. The tools and implements used on the American farm cost approximately $100,000,000 a year. The farmer must make this large outlay because it is only through this means that he can offset the scarcity and high price of farm labor; but farm implements are becoming each year more complex and costly and require a greater knowledge of mechanical principles to select and use them. The purpose of this work is to aid the present generation of farmers in acquiring this knowledge and to aid the agricultural colleges and experiment stations in the preparation of courses of instruction for the more effective equipment of the coming generation.

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NEW BUILDINGS FOR THE DEPARTMENT.

The need of better buildings for the Department of Agriculture has long been felt. For the past fourteen or fifteen years attention has been called from time to time to the inadequate structures, especially in so far as relates to laboratory uses. Six years ago systematic effort was undertaken to secure buildings commensurate with the needs of the Department. Preliminary appropriations were made for plans, which were followed eventually by appropriations for the buildings themselves. The Department now has under construction two wings, constituting a part of a series of buildings which, when completed, it is believed will meet the requirements of the work. Every effort has been made to have these buildings constructed with due regard to the important work which the Department is conducting and in recognition of the fact that Washington itself is destined to have a system of public buildings second to none in the world. The present structures, which will cost about $1,500,000, will be completed in two years, and by that time it is hoped that further appropriations will be available for a continuation of the building work inaugurated.

GROWTH OF THE DEPARTMENT.

The history of this Department's growth during the past eight years may be epitomized in the statement that the appropriations for its use have increased from $2,500,000 in 1897 to considerably over $6,000,000 in 1905, and that this increase in appropriations has been accompanied by a much greater increase in the amount of work done. Not only has the work of the Department been vastly augmented, but its scope has been correspondingly broadened and its practical value heightened.

Another interesting evidence of the growth of the Department during the past eight years is afforded by the records of the appointment clerk's office. These show that the total number of persons on the rolls of the Department of Agriculture July 1, 1905, was 5,446. Of this number those rated as scientists and scientific assistants numbered 2,326. On July 1, 1897, the total number of persons on the rolls of the Department was 2,443, of which number those rated as scientists and scientific assistants numbered 925. These figures show an increase in the total force during these eight years of 3,003 persons, while the increase in the number of those rated as scientists and scientific assistants was 1,401.

CONCLUSION.

It has been my gratifying task in the foregoing pages to present to you, and through you to the American people, a pen picture of the American farmer as he is to-day; to make clear the position of the

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farming industry and its relation to other industries; its wonderful productiveness and its large contributions to the general prosperity the country enjoys.

I have also sought to point out some of the more important work accomplished by the Department, illustrative of the methods by which it seeks to work for the practical benefit of the farmer. The work of this Department is twofold. It must seek to add to the sum of intelligence of the man and to increase the productive capacity of the acre. In this important work it has the hearty cooperation of the State agricultural colleges and experiment stations, all of them working with the Department of Agriculture toward the same great end. The gratifying evidences of well-being in our farming community, the extraordinary progress made in the past few years, and the rapidly enlarging recognition of the true position of the farming industry in the economic life of this country are mainly the result of this continued and combined effort on the part of these agencies to add to the sum of the farmer's knowledge, and must be regarded as the triumph of intelligence in the application of scientific knowledge to the tillage of the soil. This is so obviously true that it would seem superfluous to urge the generous maintenance of the Department in its grand work. Great as has been the work undertaken and accomplished, gratifying as have been the results, as shown in the first few pages of this report, be it remembered that we are still at the threshold of agricultural development, and that the educational work which has led to such grand results has only been extended as yet to a portion of our agricultural population. There is not an intelligent, patriotic citizen in the Union who will not say with his whole heart, "Let the good work go on."

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 22, 1905.*

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DEPARTMENTAL REPORTS.

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REPORT OF THE CHIEF OF THE WEATHER BUREAU.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, D. C., July 28, 1905.

SIR: I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1905.

WILLIS L. MOORE,
Chief of Weather Bureau.

Hon. JAMES WILSON, *Secretary.*

REVIEW OF TEN YEARS' WORK.

The present Chief of the Weather Bureau completed ten years of service as such on July 4, 1905, having served previous to his appointment as Chief of the service nineteen years in the various subordinate grades. It may, therefore, not be inappropriate at the end of this decade to make a brief survey of the development of the weather service during his administration.

It is probable that there is no part of the Government service in which rigid discipline is more necessary to its well-being than in the United States Weather Bureau. It has to do with the saving of life and property. While its observations are made with scientific precision, its warnings of danger from floods, from gales, or from frigid air are the results of empirical reasoning, and, therefore, even with favoritism eliminated from its personnel, and with the maintenance of the highest form of the merit system of appointment, promotion, and preferment, there will still be a small percentage of error in its warnings. The public is entitled to know, however, that it is only by the maintenance of a high standard of official integrity that the percentage of error is reduced to and kept at a low figure.

The following statement of appropriations, disbursements, and unexpended balances from July 1, 1895, to June 30, 1905, ten years, shows that the average per annum increase in the appropriations for the support of the Weather Bureau has only been 4.41 per cent; that during three years of this period there was an actual decrease in the appropriations, and that during no year was there a deficit, but that each year a considerable sum of money—in one case amounting to over $71,000, in another to $13,000, in another to over $9,000, and in still another to over $8,000—was returned to the Treasury as unexpended balance.

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Appropriations, disbursements, and unexpended balances from July 1, 1895, to July 1, 1905.

Fiscal year.	Amount appropriated.	Amount disbursed.	Amount unexpended.	Per cent of increase in appropriations.
1896	$885,610.00	$814,584.17	$71,145.30	0.82
1897	883,772.00	870,581.46	13,190.54	b.21
1898	883,702.00	877,838.35	5,863.65	b.01
1899	1,015,502.00	1,007,982.92	9,539.08	14.91
1900	1,022,482.00	1,014,238.80	8,243.20	.68
1901	1,058,320.00	1,052,626.99	5,693.01	3.51
1902	1,148,320.00	1,146,769.16	1,550.84	8.50
1903	1,263,760.00	1,256,752.90	7,007.10	10.05
1904	1,248,520.00	1,245,653.81	2,866.19	b1.21
1905	1,337,740.00	a1,336,198.58	a1,541.42	7.14

a Estimated. b Decrease.

Again referring to the fact that the average per annum increase in the cost of the weather service during the past ten years is only 4.41 per cent, it is significant, as showing the benefit to the weather service of a determination to apply the spirit as well as the letter of the civil-service law, that the daily distribution of forecasts and warnings, or of printed charts containing the daily meteorological data of the United States, has increased from 22,582 to 622,880 copies, of which 158,000 represent printed reports.

The frequently expressed opinions of persons who represent the important interests that the Weather Bureau was created to serve, show that it has made such progress in its internal discipline and in the results accomplished for the benefit of the farmer, the mariner, the shipper, the manufacturer, and the seeker after health or pleasure, that there is no weather service anywhere in the world comparable with it. It has received the commendation of citizens of this country as well as the encomiums of scientists, both at home and abroad, many of whom come here to study its organization. In recent years it has been equipped with standard instruments, apparatus, and furnishings of the latest design; daily maps are printed at nearly 100 of its local stations; large glass maps, containing the current weather reports, are exhibited each morning before important commercial associations; maps, either neatly printed or milleographed, are distributed within three hours from the time that the observations are made. Climatic statistics for the various States are collected from nearly 4,000 voluntary observers using standard instruments, and printed in the form of monthly State bulletins, so that the climate of one region can be readily compared with that of another. It has extended its network of stations around the Caribbean Sea and the Gulf of Mexico, so that no destructive tropical storm may come without warning. It has established stations in Bermuda and in the Bahamas, and arranged for cable cooperation in the Azores and along the western coast of Europe, which enables it to make forecasts for two or three days in advance for steamers leaving this country, and to warn steamers leaving Europe for America of severe storms which they may encounter on their western voyage. With kites and mountain stations it has explored the upper air and gained useful knowledge. It has conducted experiments in wireless, or space, telegraphy, and developed one of the best wireless systems now in use. It has extended its system of telegraphic and climatic

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observations so that now, except in some portions of the Rocky Mountain States, the temperature and rainfall conditions of nearly every county can be ascertained; these observations are of great benefit in the development of the arid and subarid regions, especially in the organization of the extensive irrigation works recently authorized by Congress.

It has developed and put into effect a fair, yet rigid, discipline for the control of its personnel—a system of merit in which each person works out his own status to such an extent that it is practically impossible for an incompetent or undeserving person, or a person lacking in good character, to reach any important post of duty. With this discipline there is associated a system of study and examination which develops the intellectuality of those who receive advancement. With such a discipline it has, with rare exceptions, given timely warning of the coming of injurious changes in temperature, and allowed no important storms or floods to come unannounced.

It has encouraged the study of meteorology in educational institutions by allowing its scientists, outside of their official duties, to deliver courses of lectures to students, so that there are now twenty institutions of learning where meteorology forms a part of the curriculum, thereby giving preliminary training to the young men who, in after years, will succeed to the duties now performed by the meteorologists of the Government.

Finally, three years ago the Bureau began the establishment, at Mount Weather, Virginia, of an institution devoted purely to meteorological research.

The present appropriation for the support of the Bureau is $1,392,990. This is the amount to be expended during the current fiscal year in applying the inexact science of meteorology to the commerce and the industries of the United States, and to the saving of human life. A knowledge of the coming weather enters so intimately into every contemplated human action that the question is often asked: What are the prospects for further improvement in the accuracy of weather forecasts, and can the seasons ever be foretold? The answer is that the Government has a corps of forecasters, the members of which are the survivals of the fittest in a thorough system of elimination by competition. Since they are now applying all of the knowledge of the atmosphere that has been revealed, little hope for material improvement in their work can be held out until a substantial addition is made to the pure science of the problem. This can only come through experimentation, study, and research. With 200 stations engaged in applying the science, it is a wise economy to devote at least one of them to the work of adding to the knowledge that we are annually spending nearly a million and a half of dollars to apply. Accordingly we have endeavored to lay out a plan of study and research leading to an increase in our knowledge of the laws governing the atmosphere such as should eventually enable our successors, if not ourselves, to add to the accuracy of weather forecasts and to make them for a longer period in advance.

The progress of every branch of science is necessarily slow. Four hundred years of unremitting observation and study were necessary in order to bring astronomy up to its present high standard of accuracy, and it must be expected that the complex problems of meteorology will require time for their elucidation.

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The last thirty years has witnessed such remarkable progress in new branches of science that fields of research formerly closed to the meteorologist are now open to him and justly can not be neglected. The discovery of the remarkable properties of radium has opened up a field of research relative to the ionization of gases, and this has led to a complete revolution in our ideas relative to atmospheric electricity. The studies of Professor Langley with the bolometer have led to the perfecting of similar instruments by various European and American students, so that now the analysis and measurement of sunshine and the determination of the nature and influence of the radiations that come from the sun form a fundamental field of study for the meteorologist. Recent observations have led to the discovery of a possibly large variation of the amount of heat that is received from the sun or an equivalent possible variation in the transparency of the highest portions of the earth's atmosphere, a discovery confirmed by corresponding observations in Switzerland. A year of special cloud observations all over the world has led to the downfall of erroneous views as to the general circulation of the atmosphere, while mathematical methods have been perfected that give promise of being directly applicable to the rigorous discussion of these complex motions.

In all these studies the Weather Bureau has hitherto taken a subordinate part, whereas in matters of so-called practical meteorology it has always occupied the leading position.

In order that this country may do its share toward the advancement of meteorology along the lines that specially relate to conditions in America, it is imperative that the Weather Bureau should establish an observatory for its own special research work. It would seem a severe criticism to say that the United States Weather Bureau has 200 stations for routine observations, and spends such a large amount of money annually for routine work, without doing anything for the permanent improvement of the science upon whose development its efficiency depends. It was long since stated that the highest efficiency in any art implies a perfect knowledge of the higher science behind it.

We have therefore secured a piece of land and inaugurated work at an establishment that is intended to respond to the present and prospective needs of meteorology. We have called this the Mount Weather Research Observatory, and have organized it on a broad and elastic basis, so that it may from year to year expand with the growing knowledge of our needs. The other weather bureaus of the world have been inclined to make research more prominent than practical routine. Their appointments, their promotions, and internal organization, and their whole animus, are in harmony with the principle that in the present state of meteorology research is more important than forecasts; that to establish a new law is better than to forecast rains, frosts, or storms; that, in general, our knowledge of the atmosphere and its mechanics needs to be increased, so that we may venture upon forecasts that will establish a new standard of accuracy.

In order to prosecute the researches contemplated at Mount Weather, we have established there a plant especially adapted to atmospheric research. By means of balloons and kites, the temperature, moisture, and movements of the air at great heights will be

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ascertained. The absorption of solar heat by the atmosphere will be measured by means of the pyrheliometer and actinometer. The dissipation of solar light and heat will be determined by the polariscope. The special analysis of the sunbeam will be carried out by means of the bolometer and spectrometer. The electric condition will be determined by means of the electrometer, and the radioactivity, or ionization of the air, by means of the dissipation apparatus of Ebert. To all this we have added apparatus for studying the relations to the atmosphere of the magnetism of the earth, the temperature of the soil, and even the motions of the earth as shown by the seismographs. All these phenomena have been shown to have a more or less intimate connection with meteorology.

In so far as aerial research may require it, sounding balloons will be liberated from many of the weather stations in distant parts of the country in cooperation with those at Mount Weather, since it is considered very important to know the condition of the atmosphere above the land every day of the year up to the greatest attainable height, especially during the passage of storms and cold waves. These so-called sounding balloons may attain altitudes of 20 miles; through them a record will be obtained of the winds and temperatures at that height as well as throughout the whole intermediate strata. Therefore Mount Weather may be expected to do as much for the science of meteorology and the future improvement of the service as the service has already done during the past thirty-five years for the material interests of the United States. As this country led the world in the practical application of meteorology, it is desired henceforth to lead in the development of the science itself.

In addition to the observational side of the above-mentioned studies, it is absolutely necessary to provide conveniences for experimental work—that is to say, a physical laboratory in which to investigate all questions that yield to treatment by experiment, as distinct from pure observation. There is also needed a power house and an electrical installation for the manufacture, by the electrolytic process, of the hydrogen gas for the use of balloons; this process has been demonstrated to be by far the most convenient and economical method of obtaining large quantities of pure hydrogen. It has been necessary to obtain the cooperation of the manufacturers of india rubber in order to secure a material that will retain its elasticity at the very low temperatures to which the balloons are exposed at great altitudes.

As meteorology is essentially a study of the physics of the atmosphere, the physical laboratory becomes the central life of the institution. A capable physicist has therefore been selected as the supervising director of the whole institution, and men of the highest talent for each line of coordinated research.

Similar institutions designed to carry on one or more of these lines of study have been established at Potsdam, near Berlin; Pavlovsk, near St. Petersburg; Montsouris and Parc St. Maur, near Paris, and Kew Observatory, near London, but we have combined in the Research Observatory, at Mount Weather, the principal duties that devolve upon all those observatories, with the special kite work and balloon work carried on by the famous observatory for dynamic meteorology established at Trappes, near Paris, by Teisserenc de Bort,

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the private observatory of Mr. A. L. Rotch, at Blue Hill, near Boston, and the new institution established by the Government of Prussia, at Lindenburg, about 40 miles southeast of Berlin, where aerial research will be prosecuted under Assmann.

As in the case of all these establishments, so also with the institution at Mount Weather, the employees must necessarily live close by their apparatus, and provision must be made for all the ordinary needs of domestic life precisely as is done in all large astronomical observatories and in military establishments. This has been accomplished economically and in accordance with established usage.

As it may happen that others, not employees of the Bureau, may be engaged in research that is of importance to the Weather Bureau, it is contemplated to extend to such every facility for the prosecution of their studies at this institution, in the belief that the Bureau will receive great advantage from the association of distinguished scholars and experts.

WORK OF THE YEAR, WITH RECOMMENDATIONS.

THE MOUNT WEATHER RESEARCH OBSERVATORY.

Buildings Completed and Projected.

Work on both buildings and grounds at the Mount Weather Research Observatory, Virginia, has been pushed as vigorously as circumstances would permit. The administration building and weather station was completed and equipped last fall and observations begun, which have since been used daily by the forecasters at Washington. Two magnetic observatory buildings have been completed during the year, one for absolute and one for differential determinations of the elements of the earth's magnetism. The instruments for both magnetic observatories are now being installed. The power house, which was completed during the last fiscal year, has been fitted with engines, generators, etc., for use in aerial work. All of the large machines were in place by the end of March, 1905, and work was then resumed on the revolving kite shelter, which was completed before the end of the fiscal year. Work was begun on the building for the physical laboratory in July. There are still some difficult questions regarding the best plans for the solar physics work, but as a final decision is not required at present, more time will be employed in consultation.

In planning the power house and kite shelter and in the installation of machinery in the first named, valuable aid has been rendered by Prof. Charles F. Marvin.

The schedule of apparatus for the solar physics observatory has been submitted to prominent instrument makers for estimates as to cost of construction.

The subject of solar radiation appears to be so important that early in the year the climatologist, Mr. H. H. Kimball, was instructed to prepare himself to take up this line of research at the Mount Weather Observatory. Through the courtesy of Secretary S. P. Langley, of the Smithsonian Institution, arrangements were made for the detail of Mr. Kimball to the Astrophysical Observatory for instructions and actual work in connection with the spectro-bolometric

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apparatus devised and used at that observatory. This detail commenced on May 1, 1905, and will probably continue until October of the same year. The practical experience thus gained by Mr. Kimball should be of great value to the Bureau when the study of solar radiation is taken up in earnest.

Observations with the Ångström pyrheliometer and the Pickering polarimeter have been continued at Washington throughout the year. A discussion of the results will be found in the Monthly Weather Review for March, 1905. The Ångström instrument has been carefully compared with the actinometers used by the Smithsonian Institution. It is hoped that this will enable us to connect European actinometer work with Professor Langley's spectro-bolometric work, and perhaps to thus obtain some knowledge of variations in solar radiation over a considerable period of time.

Meteorological Observations at Mount Weather.

Regular twice-daily observations of the several meteorological elements were begun at Mount Weather in November, 1904, and have been continued uninterruptedly since that time.

Personnel of Mount Weather Observatory.

The research staff has been strengthened by the appointment of William J. Humphreys, Ph. D., Johns Hopkins University, and late professor of physics in the University of Virginia, to be supervising director at Mount Weather, to take effect July 1, 1905, and the recall of Mr. Louis G. Schultz from temporary detail in Argentina in connection with the equipment of magnetic observatories in that country.

Mr. Herbert L. Solyom, recently of the U. S. Patent Office, has been appointed as a special aid to Professor Humphreys in studies of radiation, ionization, and solar physics.

The organization of the Mount Weather Observatory as at present constituted is as follows:

At Washington.

Director: The Chief of Bureau.

Board of Advisers: Prof. Cleveland Abbe, Prof. Frank H. Bigelow, chairman; Prof. Henry J. Cox, Prof. Edward B. Garriott, Prof. Alfred J. Henry, Prof. Alexander G. McAdie, Prof. Charles F. Marvin, Prof. Harry C. Frankenfield, and Prof. William J. Humphreys.

At Mount Weather.

Supervising Director: Prof. William J. Humphreys, who shall have supervision in detail of all work in the physical laboratory and solar physics observatory and general, rather than detailed, supervision of other researches. He will aid the research directors in matters wherein his knowledge may be of assistance, and will be an adviser rather than a director of their research, although in all matters of cooperation between research directors he will have the controlling voice. He will have charge of the discipline of the institution, referring to the Chief of Bureau such matters as can not be settled at the station.

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Mr. Herbert H. Kimball, who, through the courtesy of Prof. S. P. Langley, is receiving special training in the use of the bolometer in the Smithsonian Institution, will be Professor Humphreys's principal aid in solar physics, and Mr. Herbert L. Solyom, who, by the kindness of Prof. E. B. Frost, is doing special work at the Yerkes Observatory, will be an additional assistant.

DIRECTOR OF MAGNETIC AND ELECTRIC RESEARCH: Mr. Louis G. Schultz, who shall have charge of the magnetic observatories and observations in atmospheric electricity and special electric and magnetic research.

DIRECTOR OF UPPER AIR RESEARCH: Dr. Oliver L. Fassig, who shall have charge of balloon and kite observations and the discussion thereof. Messrs. Schultz and Fassig will arrange for cooperation in the taking of electrical observations from kites.

OBSERVER IN CHARGE OF PROPERTY: Mr. Charles S. Wood, who, under the general control of the supervising director, shall have charge of the premises, repairs, improvements, heating and lighting, power plants, horses and vehicles, meteorological observations and forms, and the mess and forage funds. He may correspond direct with the central office in regard to the details of the work with which he is charged.

Each official will discuss his own observations and, so far as possible, correlate the events shown by his reports with those indicated by the observations of others. There will be a cheerful willingness to cooperate for the general good of the institution and the advancement of the science of meteorology.

There will be no publication in the bulletins of the Bureau of mere argument of abstract theories in science. The place for such is the scientific publications, which are open to all. No more data will be published in the announcement of results than are necessary to make clear the subject-matter, except when the data are new.

The prime object of the institution, viz, the taking of observations and the gathering of data with which to make experimentation and prosecute research, will be kept in mind. Unpublished data will be open to the use of all recognized investigators, and cooperation with other scientific workers will be encouraged. Questions that may directly or indirectly be of value to the science of meteorology will be proper subjects for investigation. The field of inquiry will therefore be a broad one.

PROBLEMS IN INSTRUMENTAL EQUIPMENT AWAITING SOLUTION.

For a number of years Prof. Charles F. Marvin, the official in charge of the instrument division, has endeavored to give a portion of his time and efforts to the study of problems which are directly related to the development of new apparatus and the perfection of the equipment now in use. Such efforts seemed to be indispensable, in order to keep pace with the demands for better instrumental devices. Thus far, however, while the value of such work has been conceded, it has had no recognized place or funds in the yearly schedule, and much of the little that has been done was accomplished only by effort during extra hours when the official in charge of the

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instrument division could be free from the constant interruption incident to the daily routine. During the last ten years the extension of the service with respect to the instrumental equipment of stations has been very great. In 1895 only about 361 automatic instruments of all kinds were in operation at stations. The number at the present time is 1,195.

Instrumental apparatus has been greatly improved and perfected; many new designs have been brought out and other scientific work accomplished, such, for example, as the partial determination of the constants of the anemometer equation and the relation of wind velocities and pressures; the determination of vapor pressures at low temperatures; studies upon the mechanics and equilibrium of kites, etc.

At no time in its past history has the Bureau assumed such an attitude toward the solution of the scientific problems of meteorology as at the present time. Extensive preparations are being made for a comprehensive study of difficult matters that may require years for their solution. At the same time many of the simpler but equally important problems are pressing for attention which it is hoped may be given in the near future.

Some of the investigations that can be taken up when the laboratories at Mount Weather are finished are as follows:

(1) Studies in the development of practical apparatus for the measurement and registration of evaporation, both in the interest of plant physiologists and irrigation engineers.

(2) Apparatus for the better observation and the automatic registration of humidity, especially at low temperatures.

(3) Apparatus for the indication at local offices of river stages. Some work was done on this problem last year, but thus far opportunity has not offered to bring the matter to a satisfactory status.

(4) Apparatus for measurement and registration of solar radiation. This embraces not only the present type of station sunshine recorders, in which improvement is needed, but also the class of instruments known as pyrheliometers, actinometers, etc., such as have been employed for some years by Mr. H. H. Kimball in his special observations.

(5) Stations need apparatus for the more exact registration of the beginning and ending of precipitation. A device for this purpose has been partially worked out by Dr. Oliver L. Fassig, but important structural and mechanical improvements are required to render this device actually available for station use.

(6) Improvements are required in tele-thermographs. These instruments are needed at many stations.

(7) Rain gauges are needed suitable for exposure on mountain ridges remote from the habitation of the observer and in the watersheds of great rivers, so that the precipitation, snow or rain, for a whole season can be collected and measured, even though regular daily observations be not made.

(8) Apparatus intended for the recording of lightning has already received some attention, but we should be in a position to discuss the structural details of these devices and their merits and demerits on a basis of real experience.

(9) The new science of seismometry has revealed how widely sensitive the seemingly rigid earth really is to vibrations in its crust, and

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that all great earthquakes can be recorded over the entire globe by sufficiently sensitive instruments. On April 4, 1905, a great earthquake occurred in northwestern India, killing and injuring a great many people and causing the total destruction of towns and villages. The entire crust of the earth was set into elastic vibrations, which were recorded at the Weather Bureau and all over the world wherever delicate seismographs were maintained. Dr. F. Omori, secretary of the earthquake investigation committee of Japan, reports concerning the Indian earthquake that the large seismograph at Tokyo recorded first the waves proceeding from India to Tokyo direct, via Siberia, and later on those which, crossing Europe and America, reached Japan by way of the Pacific Ocean. Still more remarkable than this, the seismogram at the Osaka Meteorological Observatory showed the waves which, having reached Japan from India direct, passed on across the Pacific Ocean, America, and Europe, and finally, as it seems, returned to Japan after having made literally a complete circuit of the earth. The time required was 2 hours, 3 minutes, and 35 seconds. Certain seismic records appear to show that the crust of the earth is appreciably sensitive to great meteorological changes, and these the Weather Bureau is preparing to study with the aid of the instruments at Washington and those it is about to install elsewhere. The great delicacy of these instruments requires corresponding skill and attention in their maintenance.

(10) The Weather Bureau is almost daily in receipt of requests for information relative to high wind velocities and the relation of pressure to velocity. This is a subject in great need of further experimental investigation.

(11) Similar to the foregoing is the question of atmospheric humidity at temperatures above 100° F. The present humidity tables end at 140° F. Many inquiries are received for values at higher temperatures, such as are encountered in methods for artificial drying, etc.

The Bureau can render a distinct service to many interests by an accurate extension of the tables into the upper ranges of temperature.

There is a demand upon the Bureau for authoritative results in each of the several lines of inquiry cited, but progress on such original work has heretofore been impossible; now, however, with the completion of the physical laboratory at Mount Weather, which, it is expected, will be under roof before cold weather, and the installation of apparatus in this and other buildings at that place, these important problems may soon be attacked with hope of success in their solution.

FORECASTS AND WARNINGS.

There were but two severe atmospheric disturbances during the year, both of which were confined to Atlantic coast districts. The first assumed marked intensity on September 14–15, in the subtropical region north of the West Indies, and moved thence with considerable speed to the New England coast and the Canadian maritime provinces. It was attended along the Atlantic seaboard by excessively heavy rain and strong gales that attained hurricane force at points along the Middle and South Atlantic coasts. The maximum wind velocity reported in connection with this storm was 100 miles an hour

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from the northwest at Delaware Breakwater at 2 a. m. of the 15th, and the rainfall exceeded 5 inches at points in the Middle Atlantic States. Although the approach of this storm was announced by timely advices and warnings that prompted precautionary measures, a number of lives were lost, much damage was caused to seaside property, and many casualties to shipping occurred along the Atlantic coast of the United States.

From November 11 to 14, 1904, a storm of exceptional severity advanced from the Isle of Pines to Nova Scotia, with barometer readings of 29.08 inches at Hatteras, 28.74 inches at New York, and 28.60 inches over Nova Scotia. Attending this storm, heavy gales occurred along the coast from Eastport to Jacksonville, heavy snow fell from the Lake region over the North Atlantic States, and snow was reported as far south as North Carolina. The life-saving station at New Inlet, North Carolina, was swept away by the heavy seas and four of the men stationed there were drowned, and several vessels were wrecked along the coast. Communication by telegraph and telephone was interrupted in New England and the Middle Atlantic States, and coast towns suffered considerable damage. Storm warnings were issued well in advance of the storm as it moved up the coast and hurricane warnings were displayed for the New England coast, where it attained its maximum intensity. Undoubtedly much property and many lives were saved by the attention paid to these warnings.

The Boston Transcript remarks as follows regarding the warnings issued for the New England coast in connection with this storm:

> Ample warning was given by the Weather Bureau Saturday of the approach of the storm at a time when the skies were fair and northeasterly winds were little expected; and to the warnings is doubtless due the small number of wrecks and disasters.

A number of severe storms occurred on the north Pacific coast, and the high winds and gales accompanying them did considerable damage to shipping. The following is from the Oregonian, of Portland, Oreg., under date of November 10, regarding warnings issued in connection with these storms:

> The accuracy of the forecasts of the Weather Bureau on last week's storms was remarkable, and shipping masters who heeded the forecasts and remained in port saved money for the underwriters and much unpleasantness for themselves. Considering the violence of the gales which raged for the greater part of the week, the Weather Bureau was quite fortunate in maintaining communication with the North Head station. The service from that point is of great value to the shipping community, and Mr. Beals has been untiring in his efforts to make it as prompt and accurate as possible and is to be congratulated on his success.

NOTABLE COLD WAVES.

A cold wave of unusual intensity crossed the United States from December 24 to 29, 1904. This cold wave extended from the Dakotas to the Texas coast and from the Ohio Valley to the Gulf. During its passage the greatest 24-hour fall in temperature, 54°, occurred at Springfield, Mo.; a minimum of 36° below zero was noted at Williston, N. Dak., and the line of zero temperature extended to southern Colorado and southern Kansas. Herewith are given two of the press comments made in connection with this cold waye.

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[From the Springfield (Ill.) News of December 28, 1904.]

One of the worst blizzards in many years has swept this country, causing distress and damage. Life and property must be sacrificed to these storm monsters that no human ingenuity can control. The best that we can do is to send warnings ahead and forewarn others of its approach. This is the work the Government has undertaken in its Weather Bureau. How much life and property has been saved by the Government's system of forewarning can not be computed. There is no branch of public service that is of such immense value to the people. This is attested by the widespread credit given it and the unanimity with which shipping, mercantile, railroad, manufacturing, and farming interests watch the weather forecasts. A twenty-four hour or even twelve-hour warning of the approach of such a storm as that which swept upon us yesterday is often more than ample to protect life and property that are exposed.

[From the New Orleans Picayune of December 29, 1904.]

While the temperature has been below freezing in the sugar and trucking region around New Orleans several times this season, the freezing mark at New Orleans was registered for the first time yesterday morning. Timely warnings were scattered broadcast by the Weather Bureau, stating that planters and the public should prepare for temperatures of 24° to 28° in the sugar region and 30° at New Orleans. The prediction was fully verified. The Weather Bureau issued warnings for every severe change in the weather, and the few failures were when certain conditions which were expected did not materialize. Farming interests consider the warnings of incalculable value, and they do not complain if a prediction sometimes falls short. One freeze without warning means the loss of many thousands of dollars, and perhaps of millions of dollars, while the expense of occasional protection when a predicted freeze does not come is a very small matter. So accurate and definite have the warnings become, that no planting interest in the State has suffered from weather conditions if the warnings are believed and action taken to prevent loss and damage.

A severe cold wave appeared over the Dakotas, Minnesota, Nebraska, and Iowa on January 24, 1905, and on the 25th covered the central and upper Mississippi valleys and extended over the northern portions of the east Gulf States, the line of zero temperature reaching into northern Tennessee. On the 26th the cold wave covered Florida, and temperatures below freezing were reported as far south as Tampa and Jupiter. At the latter place the minimum temperature, 24°, equaled the lowest ever recorded since the establishment of the Weather Bureau station at that point, the lowest previous minimum having occurred December 29, 1894. Considerable damage was done to orange trees where groves could not be fired or protected. Ample warnings had been given of the expected low temperatures, and the Morning Tribune, of Tampa, in an editorial of January 26 estimated that—

But for the prompt and ample warnings given by the Weather Bureau office, and the precautions immediately taken upon receipt of these warnings by farmers and growers, the damage would have been about ten times what it really was.

DISTRIBUTION OF FORECASTS AND WARNINGS.

The work of the Weather Bureau is not confined to the issuance of warnings of notable storms and severe cold waves. A service that well represents the value of the Bureau, especially in commercial and marine circles, is the giving out daily, by telephone and otherwise, of information respecting the current weather conditions in different parts of the country.

In the distribution of forecasts and warnings little change has been made in the methods formerly employed. The distribution

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by telephone is increasing quite rapidly. Next to the daily newspaper, this method must eventually become the most effective within reach.

The following shows the distribution of daily forecasts and special and emergency warnings, by States and Territories, and the changes, as compared with the work of the previous year:

Distribution of daily forecasts and special and emergency warnings.

State or Territory.	At Government expense.			Without expense to United States by—				
	Forecasts and special warnings.	Special warnings only.	Emergency warnings.	Mail.	Rural free delivery.	Telephone.	Railroad telegraph.	Railroad train service.
Alabama	21	3	139	1,206	425	109	100	12
Arizona	3	1	0	0	0	20	0	0
Arkansas	28	5	102	581	621	84	6	0
California	139	12	0	2,541	5,071	49	0	0
Colorado	15	69	39	1,035	645	a 2	0	7
Connecticut	16	3	49	1,220	155	0	0	151
Delaware	9	0	0	72	472	0	84	0
District of Columbia	0	0	0	1,191	0	0	0	0
Florida	27	153	61	906	0	82	57	0
Georgia	39	40	241	1,593	1,558	24	217	41
Idaho	9	1	0	366	0	874	0	17
Illinois	149	21	468	3,376	9,538	113,618	98	459
Indiana	102	11	208	1,893	2,792	48,987	72	287
Indian Territory	6	1	4	170	0	4,016	114	0
Iowa	186	25	400	1,948	9,920	66,845	13	0
Kansas	81	6	186	886	5,485	3,875	15	15
Kentucky	37	37	96	2,186	75	27,094	14	0
Louisiana	33	46	61	896	115	441	6	0
Maine	21	5	40	1,116	995	7	0	77
Maryland	31	5	42	1,992	1,540	20	91	0
Massachusetts	26	18	68	3,041	310	15	0	331
Michigan	128	17	379	5,328	2,269	43,837	264	457
Minnesota	76	13	196	2,008	5,573	9,488	19	0
Mississippi	30	7	118	763	416	767	6	0
Missouri	70	7	240	5,125	2,269	17,000	25	0
Montana	13	19	18	413	0	227	0	0
Nebraska	68	8	221	1,131	1,085	1,850	0	0
Nevada	3	0	0	106	0	0	0	0
New Hampshire	22	1	34	1,207	1,398	145	0	31
New Jersey	20	28	45	1,223	305	587	176	0
New Mexico	4	2	0	60	0	0	0	0
New York	108	47	365	7,947	2,230	12,049	243	168
North Carolina	54	17	189	1,144	1,900	98	1	16
North Dakota	13	14	99	154	640	70	0	0
Ohio	103	94	457	6,568	3,080	61,490	37	17
Oklahoma	11	2	13	317	622	5,894	72	0
Oregon	18	2	0	693	675	0	0	104
Pennsylvania	61	21	367	3,871	1,553	7,375	532	0
Rhode Island	5	0	12	105	0	0	0	28
South Carolina	28	9	109	1,185	1,156	17	40	23
South Dakota	41	27	77	718	891	1,411	0	0
Tennessee	40	10	291	1,506	1,715	868	2	2
Texas	52	67	240	1,707	3,336	636	65	0
Utah	16	58	0	410	1,202	17,377	0	0
Vermont	13	1	46	586	260	38	8	13
Virginia	39	10	96	1,562	433	425	61	96
Washington	20	4	0	796	901	8	0	29
West Virginia	17	12	55	758	225	1,666	60	26
Wisconsin	100	15	298	2,096	1,722	15,178	0	16
Wyoming	7	4	8	138	40	135	0	0
Total June 30, 1905	2,158	973	6,152	77,774	75,602	464,788	2,443	2,423
Total June 30, 1904	2,076	983	6,152	77,605	83,689	152,302	2,655	2,423
Changes	+82	−10	0	+69	−8,087	+312,486	−212	0

a Practically every telephone station in the State receives the forecasts through the cooperation of the Colorado Telephone Company.

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WIRELESS DISTRIBUTION OF STORM WARNINGS TO VESSELS AT SEA.

Pursuant to recommendations in the report of the interdepartmental board on wireless telegraphy, dated July 12, 1904, and approved by the President July 29, 1904, the control of meteorological work on the oceans has been transferred from the Hydrographic Office, Navy Department, to the Department of Agriculture, and all meteorological work, heretofore done by the Navy Department for the purpose of publication or for the making of forecasts of storm warnings, has been assigned to the Weather Bureau of the Department of Agriculture.

In further compliance with the recommendations of the board, the Navy Department has instructed its wireless stations to receive and promptly transmit to the ocean, or to islands, or to other places where the information can be made useful, the storm warnings of the Weather Bureau, and has requested vessels having the use of its wireless stations for the receipt of messages to take daily meteorological observations of the weather when within communicating distance, and to transmit such observations to the Weather Bureau through wireless stations at least once daily, and to transmit observations oftener when there is a marked change in the barometer. And the recommendations provide that there shall be no charge against the Department of Agriculture for these observations or for the transmission thereof by wireless telegraphy.

In the development of the plan of transmitting storm warnings by wireless telegraphy, the cooperation of the Light-House Board of the Department of Commerce and Labor has been secured and instructions have been issued by that Department for the display and dissemination of storm warnings and advices at light-houses and light-ships that are in communication with the Naval wireless stations.

At the close of the year, the scope of the wireless work provided for the transmission of storm warnings from naval stations to offshore points as follows:

Portsmouth (N. H.) Navy-Yard to Cape Ann, Thatchers Island, Mass.
Torpedo Station, Newport, R. I., to Nantucket Shoals, Mass., light-ship.
Brooklyn Navy-Yard to Highlands of Navesink, N. J.
Norfolk Navy-Yard to Diamond Shoals light-ship, off Hatteras, N. C.
Charleston, S. C., Navy-Yard to Charleston light-vessel.
Mare Island Navy-Yard, Cal., to Yerba Buena, Cal.
San Juan (P. R.) Naval Station to Culebra, P. R. (In partial operation.)

Arrangements will be perfected at the earliest possible date for similar wireless service as follows: Portland, Me., to Cape Elizabeth, Me.; Boston Navy-Yard to Highland light, Cape Cod, Mass.; Key West (Fla.) Naval Station to Dry Tortugas, Fla., and from the Pensacola (Fla.) Navy-Yard to vessels within communicating distance.

Negotiations are also in progress with the Marconi Wireless Telegraph Company for the receipt at the station of the company at Siasconset, Nantucket Island, Mass., of wireless messages containing meteorological observations from vessels that are equipped with Marconi apparatus, and for a transmission of storm warnings to vessels that may be in communication with the station. The inauguration of a system of interchange between shore stations and vessels at sea of messages containing storm advices and meteorological observations promises an enlargement of Weather Bureau work that will be

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coextensive with the development and scope of wireless telegraphy, and the extension over the ocean of the area of meteorological reports by wireless telegraphy may, in time, permit a service to trans-Atlantic steamers about to leave American and European ports that will advise them regarding the character of the weather they will experience at sea. Furthermore, it is likely that reports that will be available with an extension of wireless telegraphy will result in a communication of storm advices to vessels in mid-ocean, and render possible a storm-warning service for the western coasts of Europe.

RIVER AND FLOOD SERVICE.

The year 1904–5, like its immediate predecessor, was not productive of serious floods in the larger rivers, although several damaging floods occurred in the smaller rivers, notably in the upper Sacramento in January, 1905; in the Purgatory and upper Arkansas rivers of Colorado; the Rio Grande, Pecos and upper Canadian rivers during the latter part of September and the early part of October, 1904, and in the Grand River of Michigan in June, 1905. The floods in the rivers of the southwest in September and October, 1904, were peculiar, in that they occurred in the semiarid region and at a time of the year when heavy rainfall is not anticipated. Their coming was not announced, since no flood service had yet been organized in that part of the country. The damage done by the floods in Colorado, New Mexico, Oklahoma and Indian Territories, and Texas amounted to at least $4,000,000, of which the greatest share fell upon the railroads. The loss among the inhabitants was not less than $1,000,000. These very destructive floods brought to the attention of the Weather Bureau the need of a flood service in the States mentioned. Such a service was organized during the winter of 1904–5, and it began operation with 15 river and 10 rainfall stations, the headquarters of the district being at Denver. Although the service is not completed, it has done much good in giving warning of the floods in the Rio Grande during May and June, 1905.

The flood of June, 1905, in the Grand River of Michigan, while not as great as that of 1904, was nevertheless a disastrous one, and that it was not even more so was without question due to the forecast and warning service given by the Weather Bureau.

EXTENSIONS OF THE RIVER AND FLOOD SERVICE DURING THE YEAR.

During the year several new districts were established and a large number of river and rainfall stations were opened. The new districts are as follows: (1) For the rivers of Ohio, with headquarters at Columbus; (2) for the rivers of Iowa, with headquarters at Des Moines; (3) for the rivers of lower Michigan, with headquarters at Grand Rapids, and (4) for the smaller streams of Mississippi, with headquarters at Meridian. These districts, while quite limited in area, were established in order that warnings might be given of the severe floods that visit them, usually during the spring months. There were also established during the year 109 special river stations and 38 special rainfall stations, distributed as advantageously as possible among the various districts. Five special river and nine special rainfall stations were discontinued during the year, and at its close there were in active operation 329 special river and 96 special

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rainfall stations. About two-thirds of these are regular reporting stations, the observers receiving compensation averaging $84 and $36 a year, respectively. In addition, daily river observations are also taken at 54 regular Weather Bureau stations, making a grand total of 383 river and 96 rainfall stations.

WEATHER-CROP BULLETINS.

The Weather Bureau issues both national and sectional weather-crop bulletins. Mr. James Berry continues to edit, with skill and intelligence, the National Weather-Crop Bulletin. The sectional bulletins are edited by Weather Bureau officials in charge of the various section centers. In addition to the bulletins mentioned, the Bureau issues a cotton region bulletin from New Orleans, La. These publications aim to give the most accurate and impartial information concerning the weather and crop conditions that it is possible to obtain through its corps of telegraphic and mail crop correspondents.

Number of cooperative observers, correspondents, etc.

Section.	Number cooperative observers.	Crop correspondents.	Publications issued.	
			Weekly bulletins.	Monthly climate and crop reports.
Alaska	24	.....	0	0
Alabama	38	401	800	500
Arizona	77	140	420	360
Arkansas	71	310	750	750
California	375	225	500	750
Colorado	82	125	1,000	1,000
Florida	59	300	900	500
Georgia	40	650	1,000	600
Hawaii	138	61	280	250
Idaho	62	200	500	300
Illinois	92	400	1,500	400
Indiana	59	379	700	725
Iowa	135	400	2,900	2,600
Kansas	99	439	1,500	1,250
Kentucky	47	300	750	515
Louisiana	46	266	650	1,000
Maryland and Delaware	52	158	720	720
Michigan	120	564	1,300	1,100
Minnesota	62	400	1,200	450
Mississippi	62	225	750	625
Missouri	86	468	1,500	452
Montana	79	190	900	800
Nebraska	144	450	1,080	535
Nevada	30	65	300	300
New England[a]	142	400	1,000	700
New Jersey	51	101	1,000	500
New Mexico	83	87	1,000	1,000
New York	126	466	1,000	800
North Carolina	55	402	1,000	1,000
North Dakota	68	306	600	500
Ohio	99	590	1,400	560
Oklahoma and Indian Territories	65	1,030	2,500	1,400
Oregon	81	223	850	750
Pennsylvania	61	168	780	600
Porto Rico	41	44	400	375
South Carolina	34	175	540	390
South Dakota	57	398	950	500
Tennessee	55	145	850	425
Texas	145	750	1,500	1,200
Utah	81	155	550	500
Virginia	53	320	525	900
Washington	79	130	800	900
West Virginia	57	250	1,200	500
Wisconsin	65	513	950	1,200
Wyoming	64	65	375	350
Yellowstone Park	6	.....	.....	.....
Total	3,656	13,834	41,670	31,582

[a] Six New England States.

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Outside of Washington, D. C., there are 44 section centers for the collection and dissemination of weather statistics in connection with crop conditions. The preceding table shows, for each section of the climate and crop service, the number of cooperating observers and crop correspondents, and the editions of the weekly bulletins and the monthly climatological reports.

SNOW AND ICE BULLETINS.

The snow and ice bulletins have been issued regularly from the beginning of December to the close of March, as heretofore. These bulletins show graphically the depth of snow over the country, and give in tabular form the actual depths reported, together with the thickness of ice in the rivers and harbors.

COTTON-REGION SERVICE.

The information upon which the reports of weather conditions in the cotton region are based is collected mainly from 146 stations distributed throughout the cotton-growing States, and reported daily by telegraph to certain district centers.

CORN AND WHEAT REGION SERVICE.

The Weather Bureau maintains a service similar to the above in the interests of the corn and wheat growing States. One hundred and thirty-four stations report the weather conditions by telegraph, daily, during the growing season, from April 1 to September 30 of each year.

For the benefit of the rice interests of Louisiana, nine subordinate stations are maintained in that State. These stations likewise report the weather conditions daily by telegraph.

BAROMETRY.

Prof. Frank H. Bigelow continues to have charge of the barometry section, and has rendered valuable aid in the organization of the Mount Weather Research Observatory.

Professor Bigelow has continued his studies on the diurnal periods in the lower strata of the atmosphere, and has published the following papers thereon in the Monthly Weather Review:

(1) The diurnal periods of the temperature.
(2) The diurnal periods of the pressure.
(3) The diurnal periods of vapor tension, the electric potential, and the coefficient of dissipation.
(4) The diurnal periods of the magnetic field and the periodic disturbances.

In addition to his studies on the above-named subjects, Professor Bigelow has delivered three courses of university lectures intended to introduce the theory of cosmical meteorology.

MONTHLY WEATHER REVIEW AND WORK OF THE EDITOR.

In addition to his work as editor of the Monthly Weather Review, Prof. Cleveland Abbe has had general supervision of the educational work in meteorology as carried on by the officials of the service, and has also given attention to educational work along these lines

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by schools and colleges in general. In the course of this work he has begun the preparation of a handbook for the use of those who are pursuing courses of education leading up to research in meteorology. He has also prepared for publication an abbreviated copy of his voluminous report of 1891 on "Climates and crops," the publication of which has been ordered, as it has been frequently requested by those who have had occasion to examine the manuscript.

The articles contributed to the Monthly Weather Review by special students and the notes by the editor, or assistant editor, have continued to occupy about two-fifths of each number and have been of exceptional interest. The increasing interest in meteorology on the part of scientists throughout the country encourages the hope that the progress of our knowledge of the atmosphere will be especially furthered by American research.

Among the noteworthy articles published in the Review for the months of June, 1904, to May, 1905, inclusive, are the following:

June, 1904: W. N. Shaw, chief of the London meteorological office, "On the general circulation of the atmosphere in middle and higher latitudes." Prof. F. H. Bigelow, "The average monthly vectors of the general circulation of the atmosphere."

July, 1904: John T. Quinn, "The movement of high clouds in the West Indies." C. C. Hutchins and J. C. Pearson, "Air radiation."

August, 1904: Stanislav Hanzlik, Ph. D., "The annual and geographical distribution of cyclones of high velocity in the United States."

Ocober, 1904: Wilson A. Bentley, "Studies of raindrops and raindrop phenomena." Joseph Bily, jr., "Thunderstorms at Tampa, Fla." Rev. F. L. Odenbach, S. J., "An index of meteorological items in the Jesuit Relations."

November, 1904: Rev. D. Hammer, "Airy's theory of the rainbow."

December, 1904: H. H. Kimball, "Evaporation observations in the United States."

January, 1905: Johnstone Stoney, "Escape of gases from the atmosphere."

February, 1905: S. Tetsu Tamura, "Mathematical theory of ice formation." Prof. A. J. Henry, "High water in the Great Lakes." E. D. Emigh, "Unusual weather at Dodge, Kans."

March, 1905: H. H. Kimball, "The variation in atmospheric transparency during 1902, 1903, and 1904."

April, 1905: S. Tetsu Tamura, "Mathematical theory of the nocturnal cooling of the atmosphere." J. L. Bartlett, "Influence of small lakes on local temperature conditions." Prof. C. F. Marvin, "The great Indian earthquake of April 4, 1905." D. A. Seeley, "A heavy deposit of hoarfrost and its effect in retarding the nocturnal cooling of the air."

May, 1905: Robert E. Horton, "Snowfall, freshets, and winter flow of streams in the State of New York." F. S. Shields, "Rainfall of the drainage area of New Orleans, La."

METEOROLOGY IN SCHOOLS.

At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. In this way a general knowledge of the work of the Bureau is being disseminated in the community. During the past year several hundred such lectures have been given, most of which are specifically recorded in the Monthly Weather Review.

CONVENTION OF WEATHER BUREAU OFFICIALS.

The third triennial convention of Weather Bureau officials was held at Peoria, Ill., September 20–22, 1904. Conventions of Weather

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Bureau officials are regarded as being of great importance, since they afford opportunity for the exchange of views and the discussion of methods for advancing Weather Bureau work. The convention was helpful not only to those who participated in it, but to all other employees of the Bureau.

A report of the proceedings, constituting a volume of nearly 300 pages, has been published.

NEW WEATHER BUREAU STATIONS.

During the year the following new stations were established and fully equipped with automatic instruments:

Madison, Wis.	Mount Weather, Va.	Lasalle, Ill.
Brooklyn, N. Y.	Devils Lake, N. Dak.	Durango, Colo.
Hartford, Conn.	Charles City, Iowa.	Peoria, Ill.
Providence, R. I.	Roswell, N. Mex.	Honolulu, Hawaii.

STORM-WARNING STATIONS.

Preparations were made just before the beginning of the fiscal year that ended June 30, 1905, to equip about ten stations with the storm-warning equipment, and contracts were closed for the necessary steel towers, lanterns, etc. It was subsequently found impossible, however, to provide sufficient funds for the whole undertaking, and the work of installation at stations could only be taken up a little at a time, as small sums of money could be spared for the purpose. Seven new stations only were equipped during the year, but towers are now at six additional stations and will be erected at an early date.

One hundred and fifty-six display stations are now equipped with steel towers. Eighty-one have high-power electric lanterns, 72 have high-power oil lanterns, and day signals only are displayed from 3 towers. In a few cases towers are not or can not be employed, but other provisions are made for the improved storm-warning displays. Thus 11 stations not included above are yet equipped with high-power lanterns.

TELEGRAPH SERVICE.

The following new cables and land lines were completed and put into operation during the year:

A 2-conductor cable from Naghead, N. C., to Roanoke Island, N. C., and the necessary land lines connecting the cable with the Hatteras-Norfolk line on one side and with the Weather Bureau station at Manteo, N. C., on the other. The station at Kittyhawk, N. C., was moved to Manteo on November 10, 1904.

A 1-conductor cable and necessary land lines to extend the existing telephonic connection between Glenhaven and South Manitou Island, Mich., to North Manitou Island, Mich. The new line was put into operation during October, 1904.

A 1-conductor cable at the mouth of the Columbia River, between Fort Stevens, Oreg., and Fort Canby, Wash., and a land line from the latter point to the Weather Bureau station at North Head, Wash. By connecting this cable with the Western Union system at Fort Stevens, direct communication was established between North Head and Portland, Oreg.

Extensive general repairs were made to the Hatteras line, including the erection of 76 miles of new copper wire and about 2,000 new poles.

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A large amount of work and new materials were also put into the Tatoosh Island section, with gratifying results.

The Government receipts from private telegrams transmitted over Weather Bureau lines amounted to $2,130.77.

LIBRARY.

During the year 820 books were added to the library, 150 of which were by purchase and 670 by gift or by exchange. New books are now catalogued under both authors and subjects, but a great many old books are still catalogued under authors only. Much work on the subject catalogue, especially in indexing climatological data, still remains to be done before the library can be brought up to its maximum efficiency.

All library shelving is now practically full. Space was found for books acquired during the year only after sending to the superintendent of documents a large number of volumes of Government publications. While many of these contained valuable data, they can easily be consulted in the libraries of the Bureaus or Departments publishing them. Enough volumes of a similar character can be disposed of to make room for the accessions of another year.

EXAMINATIONS FOR PROMOTION.

In October, 1904, the plan of conducting examinations in one or more subjects at a time was inaugurated, instead of not less than three subjects, as heretofore, when this could be done without expense to the Weather Bureau. There had been a general complaint that it was a hardship for busy employees to prepare for so many examinations at once. The change has resulted in a gratifying increase in the number of applicants for examinations, as the following table shows:

Requests for examinations.

Subjects.	1904, June.	1904, Sept.	1904, Dec.	1905, Mar.	Total.	Passed.	Failed.
English grammar	1	7	11	3	22	22	0
Arithmetic	2	6	11	5	24	24	0
Meteorology (elementary)	1	7	12	6	26	23	3
Algebra	4	4	14	13	35	33	2
Physics	4	4	6	8	22	20	2
Trigonometry	4	4	2	6	16	14	2
Astronomy	3	3	3	4	13	13	0
Botany	4	3	4	3	14	14	0
Meteorology (advanced)	4	3	3	2	12	12	0
Total	27	41	66	50	184	175	9

A change has been made in the character of the examinations in advanced meteorology, so that now it is intended to test an employee's general knowledge of meteorology, especially with respect to the meteorological literature published by the Weather Bureau.

MISCELLANEOUS METEOROLOGICAL INFORMATION SUPPLIED TO THE PUBLIC.

The care of the meteorological records of the service and their tabulation for the various needs have been, as heretofore, under the

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charge of Mr. William B. Stockman, Chief of the Division of Meteorological Records. This Division continues to tabulate the meteorological data of the various stations for publication in the Monthly Weather Review and the annual climatological volumes. The Division also supplies information of a varied character to different Federal Departments and Bureaus, State, county, and city officials, civil engineers, and others.

PERSONNEL OF THE BUREAU.

CLASSIFIED SERVICE.

APPOINTMENTS.—One hundred and six appointments were made during the fiscal year—by certification, 94, at salaries ranging from $360 to $1,250 per annum; by transfer from other Bureaus, 2, at $630 and $1,000 per annum, respectively; by transfer from unclassified positions, 5, at salaries ranging from $600 to $720 per annum; by reinstatement, 5, at salaries ranging from $480 to $840 per annum.

TEMPORARY APPOINTMENTS.—There were 46 temporary appointments for periods of less than ninety days and at salaries ranging from $360 to $1,250 per annum, the greater number being station messenger boys at $360, whose appointments were made pending the obtaining of eligibles for permanent appointment; 27 emergency appointments for five to thirty day periods, at salaries ranging from $450 to $1,250 per annum. All temporary and emergency appointments were made under the authority of the Civil Service Commission.

The total number of appointments of all kinds made during the year was 179.

PROMOTIONS.—One hundred and fifty-five promotions were made, in every instance by advancement to the next higher grade.

REDUCTIONS.—Reductions necessitated by the public needs or due to change of station assignment requested by the employee, 11; because of decreased efficiency, 9 (of which 7 involved a change of station assignment); for excessive absence from duty, 3; for reprehensible conduct in connection with the improper use of Government time and property, 3; for neglect of duty, 6; for insubordination, 1; for inability to perform duties to which the employee was assigned at his own request, 1. Total reductions for the year, 34.

RESIGNATIONS.—Fifty-two voluntary separations occurred, of which 11 were made to enable the employees to accept positions in other Bureaus. Eleven resignations were required—2 for physical disabilities, 7 for inefficiency, 1 for false representations relative to absence from duty, and 1 for conduct closely approaching insubordination. Total separations by resignation during the year, 63.

DROPPED FROM ROLLS AT TERMINATION OF PROBATIONARY PERIOD.—Two probationers were refused absolute appointment because of unsatisfactory services.

REMOVALS.—For intoxication, 1; for neglect of duty, 1; for insubordination and discreditable personal conduct, 1; for absence without authority, 2; for unsatisfactory services, 1; total, 6.

DEATHS.—Deaths in classified service, 4.

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UNCLASSIFIED SERVICE.

APPOINTMENTS.—Appointments to the unclassified service numbered 10, the salaries ranging from $300 to $600 per annum, as follows: For duty at Washington, D. C., 3 (2 through the board of labor employment and 1 for an emergency period of less than one month); for duty outside the District of Columbia, 7 (2 station agents, 4 student assistants, and 1 laborer).

PROMOTIONS.—Five unclassified employees were promoted during the year, each promotion being made to the next higher grade, the salaries ranging from $480 to $720 per annum.

RESIGNATIONS.—One resignation was required on account of intemperance.

REDUCTIONS.—One unclassified employee was reduced on account of insubordination.

DISCHARGES.—One employee (a station agent) was discharged on account of unsatisfactory services.

DEATHS.—One death occurred in the unclassified service.

ABSENCES DURING THE CALENDAR YEAR 1904.

AT STATIONS.—The average absence of station employees, with pay, during the calendar year 1904 was 0.8 of a day on account of sickness and 10.1 days on account of annual leave. Ninety-nine per cent of the station employees being males, the matter of sex has been disregarded in figuring the station averages.

AT WASHINGTON, D. C.—The average absence, with pay, of employees at Washington, D. C. (officials, clerks, mechanics, messengers, and laborers), during the same period was: Males, 4.7 days on account of sickness and 25.7 days on account of annual leave; females, 9.4 days on account of sickness and 26.9 days on account of annual leave.

The general average of the entire service, station and Washington combined, was 2 days on account of sickness and 14.5 days on account of annual leave.

STATISTICS OF THE SERVICE.

The following tables show the numerical strength of the Bureau and the highest and lowest salaries paid in the classified and unclassified grades:

Numerical strength of the Weather Bureau June 30, 1905.

At Washington, D. C.:		
Classified	172	
Unclassified	11	
		183
Outside of Washington, D. C.:		
Classified	483	
Unclassified	14	
		497
Total commissioned employees		**680**

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Additional employees outside of Washington, D. C.:		
Storm warning displaymen [a]	159	
River observers	344	
Cotton region observers	146	
Corn and wheat region observers	134	
Rainfall observers	106	
Fruit and wheat region observers	16	
Sugar and rice region observers	9	
Total noncommissioned employees		914
Total paid employees [b]		1,594
Persons serving without compensation (except through the distribution of Government publications):		
Cooperative observers		3,665
Cooperative storm warning displaymen [c]		85
Crop correspondents		13,834
Total numerical strength		19,178

Distribution of the commissioned force.

In Washington, D. C.:		In Washington, D. C.—Continued.	
Accounts Division	13	Division of Meteorological Records	15
Barometry and research work	2	Miscellaneous mechanical work	4
Climate and Crop Division	7	Publication Division	43
Editor, Monthly Weather Review	2	Supplies Division [e]	9
Executive branch [d]	18	Telegraph Division [e]	11
Forecast Division (including River and Flood Service and Section of Ocean Meteorology) [d]	20	Captain of the watch (under direction of the chief clerk)	25
Instrument Division	10	Total	183
Library	4		

Outside of Washington, D. C.:

62 stations	with 1 employee	=	62 employees.
53 stations	with 2 employees	=	106 employees.
28 stations	with 3 employees	=	84 employees.
19 stations	with 4 employees	=	76 employees.
15 stations	with 5 employees	=	75 employees.
4 stations	with 6 employees	=	24 employees.
3 stations	with 7 employees	=	21 employees.
1 station	with 8 employees	=	8 employees.
4 stations	with 9 employees	=	36 employees.
1 station	with 10 employees	=	10 employees.
190 stations.			[f] 502 employees.

In addition to the above, there are seven one-man stations in the West Indies in charge of noncommissioned employees (agents of cable companies).

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[a] The number of displaymen (236) given in the report for 1904 included cooperative displaymen serving without compensation.

[b] This total embraces all paid employees in the Bureau on June 30, 1905, including the Chief of Bureau, but excluding employees on furlough for three months or more.

[c] Thirty-six of these cooperative displaymen are employed in other branches of the Government service.

[d] One man devotes half his time elsewhere.

[e] Plus one-half the time of one man.

[f] This number represents the *normal* regular station force. On June 30, 1905, there were actually on duty but 497 employees.

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Salaries paid in the classified and unclassified grades.

Grades.	June 30, 1905.	
	Station.	Washington, D. C.
CLASSIFIED GRADES.		
Highest salary	$3,000	$5,000
Lowest salary	360	450
Average salary	991	1,198
UNCLASSIFIED GRADES.		
Highest salary	720	720
Lowest salary	300	240
Average salary	399	475

Average salary for all (station and Washington, including the Chief of Bureau), $1,021.

The foregoing table of salaries does not include employees on duty at substations (storm-warning displaymen, river observers, etc.), whose compensation ranges from $5 to $20 per month, and whose tour of service would average less than one hour a day, and seven station agents in the West Indies at $25 a month.

OBSERVATORY BUILDINGS.

The Weather Bureau completed the erection, during the fiscal year, of six buildings, and also has in course of construction six additional buildings. The following tables give the number of buildings owned by the Weather Bureau, the number in course of construction, the number of rented buildings occupied wholly for office and living purposes, and the stations at which living quarters are furnished by the Government separate from offices:

Buildings owned by the Weather Bureau.

Location.	Value of lot	Value of buildings.	Total value.
Amarillo, Tex	$1,255.00	$6,503.00	$7,758.00
Atlantic City, N. J	(a)	6,000.00	6,000.00
Bismarck, N. Dak	(a)	10,000.00	10,000.00
Block Island, R. I	1,100.00	7,700.00	8,800.00
Cape Henry, Va	(a)	9,104.25	9,104.25
Columbia, S. C	3,799.00	9,170.00	12,969.00
Devils Lake, N. Dak	2,300.00	8,000.00	10,300.00
Duluth, Minn	2,100.00	7,900.00	10,000.00
Hatteras, N. C	125.00	4,875.00	5,000.00
Havre, Mont	1,850.00	5,700.00	7,550.00
Jupiter, Fla	(a)	6,094.95	6,094.95
Key West, Fla	2,020.00	7,994.75	10,014.75
Kittyhawk, N. C	(a)	1,616.00	1,616.00
Modena, Utah	(a)	4,346.00	4,346.00
Mount Weather, Va.:			
Observatory building	2,000.00	18,000.00	20,000.00
Power house and balloon building	650.00	8,000.00	8,650.00
Absolute building	(a)	6,500.00	6,500.00
Variation building	(a)	8,000.00	8,000.00
Kite building	(a)	3,000.00	3,000.00
Stable		2,000.00	2,000.00
Mount Washington, N. H	(b)	300.00	300.00
Nantucket, Mass	1,236.50	3,968.00	5,204.50
Narragansett Pier, R. I	4,100.00	8,000.00	12,100.00
North Head, Wash	(a)	4,000.00	4,000.00
Peoria, Ill	54.00	7,915.00	7,969.00
Point Reyes Light, Cal	(a)	3,000.00	3,000.00
Port Crescent, Wash	82.00	1,000.00	1,082.00

[a] Government reservation. [b] Leased.

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Buildings owned by the Weather Bureau—Continued.

Location.	Value of lot.	Value of buildings.	Total value.
Sand Key, Fla	(a)	$5,593.00	$5,593.00
Sault Ste. Marie, Mich	(a)	3,000.00	3,000.00
Southeast Farallon, Cal	(a)	5,211.22	5,211.22
Tatoosh Island, Wash	(a)	5,000.00	5,000.00
Washington, D. C	$25,000.00	150,000.00	175,000.00
Yellowstone Park, Wyo	(a)	11,500.00	11,500.00
Yuma, Ariz	(a)	1,500.00	1,500.00
Total	47,671.50	350,491.17	398,162.67

[a] Government reservation.

Weather Bureau buildings in course of construction, and approximate cost of each.

Location.	Cost of lot.	Cost of buildings.	Total cost.
Bentonville, Ark	$500.00	$5,500.00	$6,000.00
Burlington, Vt	(a)	10,000.00	10,000.00
Mount Weather, Va., physical laboratory building	(b)	[c] 13,000.00	[c] 13,000.00
North Platte, Nebr	1,000.00	3,000.00	4,000.00
Oklahoma, Okla	(d)	10,000.00	10,000.00
Springfield, Ill	(b)	10,000.00	10,000.00
Total	1,500.00	51,500.00	53,000.00

[a] Donated by University of Vermont.
[b] Government reservation.
[c] One-half cost, as building will take two years to complete.
[d] Donated by Epworth University.

Rented buildings occupied wholly by the Weather Bureau.

Station.	Annual rent.	Other items included.
Alpena, Mich	$650.00	Heat, light, water.
Anniston, Ala	475.00	
Charles City, Iowa	420.00	Heat, light, water.
Durango, Colo	440.00	Heat, cleaner, water.
East Clallam, Wash	120.00	
Flagstaff, Ariz	300.00	
Helena, Mont	504.00	Heat, water.
Independence, Cal	430.00	Heat, light, water.
Iola, Kans	468.00	Heat, light, water.
Kalispell, Mont	360.00	
Lewiston, Idaho	540.00	
Manteo, N. C	96.90	
Moorhead, Minn	600.00	Heat, light, water.
Mount Tamalpais, Cal	420.00	Heat, light, water.
Roseburg, Oreg	550.00	Heat, light, water.
Roswell, N. Mex	720.00	Heat, cleaner, light.
Santa Fe, N. Mex	360.00	
Santo Domingo, W. I	480.00	
Thomasville, Ga	420.00	
Twin, Wash	100.00	
Williston, N. Dak	450.00	Heat, cleaner, light, water.
Winnemucca, Nev	360.00	Heat, light, water.
Yankton, S. Dak	500.00	Heat, light, water.

Stations at which observers' quarters are furnished by the Government separate from offices.

Station.	Annual rent.	
	Office.	Residence.
Havana, Cuba	[a]	$300.00
Honolulu, Hawaii	$480.00	540.00

[a] Public.

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RECOMMENDATIONS CONCERNING APPROPRIATIONS FOR 1907.

STATUTORY SALARIES.

One clerk at $1,200, one clerk at $1,000, and one clerk at $900 are submitted. This increase is made necessary by the natural growth and normal development of the work of the Bureau, and especially by the proposed increase of eight stations.

LUMP-SUM APPROPRIATIONS.

An increase of $20,000 is submitted under "Salaries, station employees," and is to cover the services of officials and employees required to establish and maintain eight new stations.

An increase of $131,000 is submitted under "General expenses, Weather Burean," as follows: Ninety-six thousand dollars for the purchase of ground and the erection of eight observatory buildings for the establishment of eight new stations; $20,000 for the purchase of supplies and instruments for equipping eight new stations, and $15,000 to cover the increased cost of supplies and telegraphing for old stations.

An increase of $7,000 is submitted under "Buildings, Weather Bureau," to cover the increased cost of these buildings, due to the increased cost of building materials.

As it will not be necessary to construct any "cable and land lines," the appropriation of $35,000 for that purpose has been omitted.

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REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 8, 1905.

SIR: I have the honor to submit herewith a report of the operations of the Bureau of Animal Industry for the fiscal year ended June 30, 1905.

Respectfully, D. E. SALMON, *Chief.*

Hon. JAMES WILSON, *Secretary.*

TUBERCULOSIS.

TUBERCULOSIS OF HOGS.

The increasing proportion of tubercular hogs found by the meat-inspection service is a matter of grave concern for the producer, for the packer, and for the consumer. During the past fiscal year 0.25 per cent of all carcasses inspected were condemned and destroyed because affected with this disease. During the month of July, 1905, the condemnations for tuberculosis were 1.47 per cent of all the hogs killed at one of the largest packing houses in this country, while at another equally large establishment the condemnations for the same month reached 1.35 per cent of all carcasses. In addition to the carcasses condemned there were as many more slightly affected which were not condemned. In other words, about 3 per cent of the hogs coming to some of our largest abattoirs are affected with tuberculosis.

This fact indicates a rapid increase of the disease among this species of animals, and calls for a searching investigation as to the cause and the most certain means of control. No doubt the running of hogs in the same pastures with cattle, the feeding of unsterilized milk from the creameries, and the practice of many farmers of allowing their hogs to consume the carcasses of cattle which have died of disease are causes to which a part of the infection may be attributed; but the time has come to inquire if the breeding stock of pure-bred hogs has not become contaminated to such a degree that the disease is being disseminated by such animals and the stream of hog production poisoned at its source.

The hog carcasses destroyed on account of this disease last year would have cost the packers at present prices nearly $1,000,000, and at the present rate of condemnation there would be nearly

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twice as many seized. Up to this time the loss has fallen upon the packers, but undoubtedly a way will soon be found by them to shift the burden upon the producer. A loss of from $1,000,000 to $2,000,000 a year from this cause is a very serious one, and the farmers can ill afford to have this added to the other losses which they suffer from hog diseases.

The subject is one which calls for immediate inquiry and for adequate measures of control before the disease becomes so prevalent as to make repression a difficult or impossible task.

EXPERIMENTS WITH TUBERCLE BACILLI.

The comparative study of tubercle bacilli from varied sources which has been carried on for several years by the Pathological Division has been completed and the results of the investigation are in course of publication. In addition to the human and bovine cultures that were used in the above work, numerous other cultures have been obtained during the past year from birds and wild animals of varied species which have succumbed to tuberculosis while in captivity. These cultures are under such cultural inoculation tests as will determine their characteristics and locate them in their relation to the tubercle bacilli previously studied. It having been found that morphological and cultural characteristics are not always trustworthy as indicators of the origin of some particular cultures of tubercle bacilli, the method of reaching such determination by means of the chemical reaction in cultures growing upon glycerin bouillon has appeared worthy of investigation. Many cultures have been submitted to this test, and the results will be recorded soon. The extent of the immunity from tuberculosis which may be given cattle by means of intravenous inoculations with attenuated cultures of tubercle bacilli is under study. This opportunity will also be utilized to determine if the tubercle bacilli so injected into the circulation of cows during the period of lactation are excreted in the milk as well as in the saliva and urine.

New regulations in regard to the condemnation of tuberculous carcasses have been sent to the inspectors of the Bureau for the purpose of gaining greater uniformity in the disposal of the slightly affected carcasses, and many tuberculous glands and other parts of hogs and cattle have been sent to the laboratory that the real extent of the disease might be determined through microscopical examinations and inoculation experiments. This has been very helpful in assisting inspectors at the abattoirs to estimate accurately from the naked-eye appearance of the dressed carcass the degree of progress which the disease has made within the tissues of the animal, and has thus helped them in making proper disposition of the affected meat.

The results of the experiments in the Biochemic Division concerning the infectiousness of human tubercle bacilli for cattle were published during the past year as Bulletin 52, Part II. Certain observations published as Circular 60 of this Bureau show that tubercle bacilli of bovine origin may grow out into long filaments, the usual short form of bovine tubercle bacilli becoming long when the organism is grown upon a specially prepared medium. A number of experi-

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ments are in progress now looking to a better understanding of the chemical changes produced in nutrient media by the growth of tubercle bacilli upon them.

THE DISTRIBUTION OF TUBERCULIN.

During the past year 75,041 doses of tuberculin were prepared in the Biochemic Division and shipped to authorized health officers in the States named below and in the quantities indicated:

Doses of tuberculin distributed, fiscal year 1904–5.

	Doses.		Doses.
Arizona	12	New Jersey	1,783
California	278	New Mexico	108
Colorado	126	New York	99
District of Columbia	604	North Carolina	351
Georgia	132	North Dakota	340
Idaho	48	Ohio	327
Illinois	42	Oklahoma	78
Indiana	3	Oregon	425
Iowa	534	South Dakota	60
Kentucky	56	Texas	3
Maine	81	Utah	44
Maryland	46	Virginia	186
Massachusetts	17,080	Vermont	17,236
Michigan	773	Washington	5,138
Minnesota	18,717	Wisconsin	4,600
Missouri	815		
Montana	4,700	Total	75,041
Nebraska	216		

At the experiment station of the Bureau considerable time has been spent in collecting and preparing for publication the data of the tuberculosis investigations of the past three or four years. Cow No. 218, mentioned in my last two reports, is still on hand. This cow received an injection of human tubercle culture into one quarter of her udder, and on June 27, 1905, nearly three years and nine months after the injection was made, the material secreted by the injected quarter of her udder was infectious for guinea pigs on subcutaneous injection. Mention was also made of her having produced a calf. This calf sucked its mother until it was 12 months old, and is now in excellent condition. Tuberculin tests of both cow and calf were made in February, 1905, and both were negative. The unaffected quarters of the cow's udder produced a considerable quantity of normal milk, which was tested on guinea pigs, with negative results. The injected quarter of the udder remained very much shrunken, and at best did not secrete above 6 c. c. of material per day. This material had the appearance of very poor milk, but on standing threw down a gray precipitate.

THE TUBERCULIN TEST IN ENGLAND.

The Department regulations in Bureau of Animal Industry Order 109 provide for the tuberculin testing of all cattle over 6 months old to be imported for breeding purposes from Great Britain and Canada. Those from Great Britain must be tested by an inspector of this Bureau who is stationed in that country; those from Canada are admitted upon a certificate of tuberculin test by a Canadian official

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veterinarian or an inspector of this Bureau. Cattle tested with tuberculin by the Bureau inspector in Great Britain, with the results, during the fiscal year ending June 30, 1905, are given below:

Results of tuberculin test in England of cattle for importation.

Breed.	Passed.	Rejected.
Ayrshire	7	5
Guernsey, in England	3	2
Highland	3	0
Dexter Kerry	7	3
Shorthorn	2	1
Total	22	11

BLACKLEG.

IMPORTANCE OF DISTRIBUTING BLACKLEG VACCINE.

During the last seven years the Bureau has been distributing blackleg vaccine to the stock raisers of the country, who use it to protect their young cattle from the disease known as symptomatic anthrax, or, popularly, as blackleg. At the beginning of the distribution the losses from this disease were very serious, amounting to 10 to 15 per cent of the young stock annually. By the use of the vaccine the loss has been reduced to one-half of 1 per cent, and the disease seems to be disappearing. It was anticipated that by continuing the vaccination for a series of years the infection in the soil, not being renewed, would gradually die out, and in the course of time it would be possible to dispense with the vaccination. As the bacillus of this disease forms spores, it lives for a long time in the soil, and only experiments continued for a considerable number of years could determine how long a time would be required for the eradication of the contagion.

This distribution of vaccine is therefore very important both to prevent the annual losses and as a means of eradicating the contagion from the infected pastures; and, in fact, the cattle industry in some sections is dependent upon it, as cattle could not be profitably raised without vaccination, owing to the heavy losses from this disease. The Bureau should consequently continue to supply this vaccine as one of the cheapest and most efficient means of protecting the stock raisers from the ravages of disease.

DISTRIBUTION OF VACCINE DURING THE YEAR.

The preparation of vaccine and its free distribution to cattle owners in all parts of the United States has been continued in the Pathological Division during the past year. The large number of doses distributed and the small cost of production to the Government, in comparison with the immense saving afforded cattle raisers and feeders, render this the most important routine work of the pathological laboratory. The table below shows that the demand for vaccine has increased 59,130 doses over that supplied during the previous year. As usual, the greatest call for the material occurred during the fall and spring, the highest monthly output being

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recorded in October, when over 245,000 doses were distributed. During the entire year a total of 1,395,970 doses were sent out, and the distribution of these among the various States, as well as the general results obtained from the vaccine supplied during the preceding year, may be seen in the tables.

Doses of vaccine distributed during the fiscal year ended June 30, 1905.

	Doses.
July 1 to December 31, 1904:	
July	**32,875**
August	**68,665**
September	**99,170**
October	**245,050**
November	**235,065**
December	**132,245**
January 1 to June 30, 1905:	
January	**95,920**
February	**69,435**
March	**152,540**
April	**132,940**
May	**67,540**
June	**64,525**
Total	**1,395,970**

Results obtained from vaccine distributed during the fiscal year ended June 30, 1904.

State or Territory.	Number of reports.	Number of cattle vaccinated.	Deaths same season previous to vaccination.		Died after vaccination.					
			Number.	Per cent.	Within 48 hours.	From 2 to 7 days after.	Within 1 year.	Number of cases due to mistakes.	Total number.	Percentage of deaths.
Arizona	40	4,653	92	1.97	2	8	13	.....	23	0.49
Arkansas	22	1,165	71	6.09	.....	3	11	.....	14	1.20
California	478	61,261	812	1.32	38	46	221	2	307	.50
Colorado	567	68,560	856	1.24	11	84	290	12	397	.57
Idaho	49	3,057	86	2.87	3	.....	4	2	9	.29
Illinois	60	2,699	101	3.77	1	.....	15	.....	16	.59
Indiana	6	252	10	3.96	.....	.....	14	.....	14	5.55
Indian Territory	48	3,812	133	3.48	1	6	20	.....	27	.70
Iowa	116	6,701	171	2.55	8	5	27	.....	40	.59
Kansas	898	76,493	1,479	1.29	34	110	201	7	352	.46
Kentucky	32	1,178	63	5.34	1	.....	1	.....	2	.16
Michigan	5	504	9	1.78	.....	1	.....	.....	1	.19
Minnesota	40	2,922	74	2.53	.....	.....	1	.....	1	.03
Missouri	704	101,300	802	.79	19	47	204	1	271	.26
Montana	345	35,489	676	1.90	8	16	70	18	112	.31
Nebraska	1,793	139,003	2,520	1.81	95	152	612	33	892	.64
New Mexico	25	4,398	144	3.27	2	3	55	22	82	1.86
New York	14	482	29	6.01	.....	.....	5	.....	5	1.03
North Carolina	27	1,267	32	2.52	1	.....	1	.....	2	.15
North Dakota	469	42,494	740	1.74	12	39	155	2	208	.54
Oklahoma	84	7,225	148	2.04	1	5	26	.....	32	.44
Oregon	79	10,846	144	1.32	3	4	10	.....	17	.15
South Dakota	484	48,383	881	1.82	19	36	154	.....	209	.43
Tennessee	42	1,002	86	8.58	10	.....	7	.....	17	1.69
Texas	876	145,113	2,368	1.63	69	155	718	11	953	.65
Utah	19	3,522	33	.93	1	2	9	.....	12	.34
Vermont	7	113	24	21.23	1	.....	6	.....	7	6.19
Virginia	274	8,612	215	2.48	1	5	40	.....	46	.53
Washington	105	3,632	145	3.99	.....	6	15	.....	21	.58
West Virginia	103	3,183	85	2.67	4	4	23	.....	31	.97
Wisconsin	9	281	17	6.04	.....	.....	6	.....	6	2.13
Wyoming	299	50,912	472	.92	14	69	152	4	239	.44
Other States	6	274	2	.72	.....	.....	.....	.....	.....	.....
Total	8,125	840,788	13,520	1.60	359	806	3,086	114	4,365	.51

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There are several interesting features connected with the above table. For instance, the annual loss from blackleg before vaccination in those localities where cattle are not immunized yearly or where they have not been vaccinated in time is lower than ever, indicating that there is less blackleg in the country than in any year since vaccination began. It is also gratifying to know that the number of cattle which died as a result of carelessness, or of any other acknowledged mistake, has been reduced to 114 cases. In estimating the merits of the vaccine it is necessary to deduct this number of deaths admittedly due to mistakes, and the number of cattle which died within two days after inoculation as a result of having been infected prior to vaccination from the total number of deaths following inoculation. We would therefore have 3,892 deaths following the injection of over 840,000 animals, or a mortality of 0.46 per cent.

HOG CHOLERA.

Further experiments in the biochemic laboratory have thoroughly substantiated the statement in Circular 41, to the effect that a filterable virus is chiefly, if not wholly, responsible for the outbreak of the highly infectious form of hog cholera met with in southwestern Iowa. This filterable virus is present in the blood of sick hogs and is capable of inducing an attack of the disease when injected subcutaneously. When the blood serum of sick hogs is diluted with ten volumes of salt solution or with beef broth the virus readily passes through the finest porcelain filters, and this filtered serum is then capable of bringing on a typical attack of disease in hogs when injected subcutaneously, although it is without effect upon rabbits, guinea pigs, white rats, gray rats, white mice, gray house mice, and chickens. The disease produced in hogs by the filterable virus possesses all the characters seen in the natural disease, viz, contagiousness, infectiousness of the blood upon subcutaneous injection, immunity in those hogs which recover, and also the characteristic lesions and symptoms. All efforts to discover an organized form in the filtered serum have failed, and attempts to cultivate the unknown virus on the various media were equally fruitless.

Parallel with the experiments with the filterable virus a series of experiments was carried out with pure cultures of *B. cholerœ suis*, which has been heretofore regarded as the sole cause of hog cholera. The use of that organism, however, failed to produce a disease which was contagious, or which showed the characteristic infectiousness of the blood during the course of the disease and immunity in those which recover. The details of these experiments are given in Bulletin No. 72. At the experiment station of the Bureau the endeavor has been made to produce a vaccine with virulent blood attenuated by mixture with glycerin and subjecting it for varying periods to a temperature somewhat above the fever temperature of animals or allowing it to age at room temperature or at a lower temperature. It was found that the germicidal and attenuating powers of different glycerins vary greatly, probably due to impurities in the glycerin. It was also found that blood left at ordinary room temperature and exposed to diffused sunlight loses its virulence much more rapidly

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than that kept in a dark chamber at a fairly constant but slightly lower temperature. This applies to dried blood as well as glycerinated blood. In a number of instances immunity was conferred by injections of either heat or time attenuated glycerinated blood, but these results have not been constantly confirmed.

Several remedies reported to have given excellent results were tested, but all proved valueless as remedies for hog cholera.

TEXAS FEVER.

In the Division of Zoology ticks have been studied to determine their habits and rôle in the transmission of disease, especially Texas fever. The Texas fever tick ordinarily remains upon one host during its development from the larva to the replete ovigerous female, but experiments show that this is not always the case. If ticks are removed from a cow shortly after the first molt and placed upon another cow, they will attach themselves and mature upon the latter, and the same is true in regard to ticks thus transferred at the time of the second molt. These facts may explain certain cases of Texas fever, which sometimes develop in susceptible cattle within a few days after exposure to the tick-infested animals, the interval of time between exposure and appearance of symptoms being so short that it is impossible for infection to take place in the usual manner; that is, through the second generation of ticks, which require, under the most favorable circumstances, not less than two weeks, and usually much longer, to hatch out. In such cases it seems not improbable that ticks which have been rubbed off or otherwise detached from infested animals have fastened upon the susceptible cattle and infected them. Texas fever ticks removed from a cow just before the second molt molted and remained alive in the laboratory over two weeks, and ticks thus removed readily attached themselves to human beings and to rabbits, and sucked blood. This indicates that other animals than cattle and horses may, under a proper combination of circumstances, act as disseminators of Texas fever ticks. Heretofore the Texas fever tick, *Rhipicephalus* (*Boophilus*) *annulatus*, has been the only species of the genus known to occur in this country, but a second species, *Rhipicephalus sanguineus*, has recently been collected in Texas. The occurrence of this form in the United States is worthy of note for at least two reasons—first, it is a member of a genus several species of which are known to act as transmitters of disease among domestic animals, and, second, the females of the Texas fever tick and of *Rhipicephalus sanguineus* bear a striking superficial resemblance to one another, so that they are liable to be confused by the careless observer.

At the experiment station southern cow No. 1, though removed from all sources of infection for ten years, still carries the parasite of Texas fever, but injections of her blood made into two susceptible animals seem to produce only a mild type of disease. Cow No. 113, mentioned in my last report as having lost her infectiousness, after being removed fifteen years from sources of infection, was injected early in the year with virulent blood to determine whether she had lost also her immunity. No disease that could be detected developed, but that her blood became reinfected as a result of this injection is shown

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by the fact that her blood injected into a susceptible animal produced rapidly fatal disease.

MYCOTIC STOMATITIS.

During the summer and fall of last year numerous letters were received relative to a disease affecting the mouth and feet of cattle in the Southwest, where it caused alarm among the stockmen owing to its similarity to foot-and-mouth disease of Europe, and gave rise to the fear that the contagion of this latter malady had spread to that section from the recent outbreak in New England. The disease was carefully investigated and found to be mycotic stomatitis, caused by grasses containing the red and black rusts. Later reports were received which indicated that this affection had made its appearance in northern California and in Oregon. An inspector sent to those points confirmed the above diagnosis. In order to give correct information concerning mycotic stomatitis, to assert its noncontagiousness, and to differentiate it from the virulent foot-and-mouth disease, which it so closely simulates, Circular No. 51 has been issued.

RABIES.

During the past year 45 suspected cases from various parts of the country have been examined. Of these, 22 resulted positively. Fourteen of this number, comprising 13 dogs and 1 cat, were received from the District of Columbia. Of the remaining 8 cases, 2 were forwarded from Georgia, 4 from Virginia, 1 from West Virginia, and 1 (the brain of a heifer) from Indian Territory. A tabulated list of these positive cases is given in the accompanying table:

Results of inoculation tests and microscopic examination for rabies.

Date.	Record No.	Kind of animal.	Received from—	Result of inoculation.	Diagnosis by histological examination.	Persons or animals bitten.
1904.						
July 6	343	Dog	District of Columbia	Positive	None made	
July 7	344	do	Savannah, Ga	do	Ganglia not forwarded.	Several persons.
July 8	345	do	District of Columbia	do	do	
July 12	346	do	Norfolk, Va	do	Not typical	1 boy.
July 18	347	do	Savannah, Ga	do	None made	
July 30	349	do	Hatton, Va	do	Ganglia not forwarded.	2 persons.
Aug. 12	350	do	District of Columbia	do	Positive	1 person and 8 dogs.
Aug. 30	351	do	do	do	do	1 person.
Sept. 22	352	do	Huntington, W. Va	do	Ganglia decomposed.	Several dogs and children.
Sept. 27	353	do	District of Columbia	do	Positive	1 person.
Nov. 1	356	do	do	do	None made	
Nov. 7	357	Heifer	Coalgate, Ind. T	do	do	
Nov. 23	358	Dog	District of Columbia	do	Positive	1 person.
Dec. 13	361	do	do	do	do	Several persons.
1905.						
Jan. 23	368	do	do	do	do	Several dogs.
Mar. 13	370	do	Manassas, Va	do	Ganglia not forwarded.	1 girl.
Mar. 14	371	Cat	District of Columbia	do	None made	
May 10	376	Dog	Norfolk, Va	do	Positive	Several dogs.
May 13	377	do	District of Columbia	do	do	1 person.
May 20	379	do	do	do	do	Several dogs.
June 14	385	do	do	do	do	Do.
June 25	387	do	do	do	Ganglia decomposed.	1 person.

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NECROBACILLOSIS.

The study of the *B. necrophorus* has occupied considerable attention, resulting in a paper on the economic importance of this widely distributed microorganism. It had been recovered previously in the Division of Pathology from multiple liver necrosis in a deer, disseminated liver abscesses in cattle, from the ulcers of the mouth and tongue in cases of necrotic stomatitis in calves and pigs, from ulcerative anovulvitis in cattle, and from cases of foot rot in sheep. This was the first demonstration of *B. necrophorus* as the cause of these two last-named disorders. During the last twelve months the economic importance of the necrosis bacillus has made itself still further apparent in the work of the Division. Rabbits suffering with Schmorl's disease, a cellulitis of the face and neck caused by *B. necrophorus*, have been brought to the laboratory for investigation, and two guinea pigs, likewise affected, were received from the Zoological Park. Chickens and a European kite from different sources, supposed to have died with so-called avian diphtheria, showed at the necropsy the presence in the exudate of *B. necrophorus*. Inoculations of the deep-seated intestinal ulcers of hog cholera and of the cheesy nodules inclosing the heads of *Echinorhynchus gigas* demonstrated the presence of the necrosis bacillus in these lesions in the pig. Two enzootics of foot rot in cattle furnished the same bacillus, and inoculation experiments showed it to be the causative factor.

In addition to the above, European observers have demonstrated *B. necrophorus* as the cause of the necrotic dermatitis of horses; of necrotic pocks found in the severer varieties of variola of cattle and swine; joint ill and necrotic omphalophlebitis of calves and foals; necrotic vaginitis and metritis of cattle; necrotic scratches and quittor of horses; necrotic inflammation and dry gangrene of the skin and subcutis of the teats and udders of cows; necrotic turbinated bones of a horse; deeply penetrating caseo-necrotic patches in all four stomachs of cattle, the paunches of deer and antelopes, small intestines of calves, cecum and colon of horses; necrotic processes on lips and nose of sheep. When it is remembered that the presence of only one of the morbid conditions noted may be the starting point of an enzootic outbreak of necrobacillosis in any of its forms among any of the domestic animals, there can be no question as to the importance of keeping the stockman fully informed as to the imminence of the infection and the prophylactic and therapeutic measures which can successfully cope with it.

CONTROL OF CONTAGIOUS DISEASES.

TEXAS FEVER.

During the quarantine season of 1904, 40,389 carloads of cattle, shipped from points below the quarantine line and intended for immediate slaughter, were received at packing centers; the number of animals carried in these cars was 1,087,474. In the noninfected areas of Texas and Oklahoma 228,277 head of cattle were inspected and permitted to be moved north for purposes other than immediate

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slaughter. Supervision was exercised over the dipping with crude petroleum of 99,040 head of cattle and over the cleaning and disinfection of 37,120 cars.

SCABIES IN SHEEP, CATTLE, AND HORSES.

The total number of inspections of sheep for scabies was 53,680,786, and the total number of dippings was 16,873,659, of which 2,703,845 were redippings. As will be seen from the following tabulation, this shows an increase over the previous fiscal year of 31 per cent in inspections and 76 per cent in dippings.

Number of inspections and dippings of sheep for scabies, and cars cleaned and disinfected, fiscal years 1900 to 1905.

Year.	Inspections.	Dippings.	Cars cleaned and disinfected.
1900	1,801,392	626,838	.....
1901	7,912,724	1,034,368	.....
1902	11,186,661	1,017,162	791
1903	16,444,370	2,167,002	752
1904	40,967,961	9,578,476	2,732
1905	53,680,786	16,873,659	7,965

The total number of inspections of cattle for scabies was 14,085,267, and the total number of dippings was 563,394, of which 114,463 were redippings. Cars cleaned and disinfected, 29,897.

The total number of inspections of horses for scabies was 15,971, and the total number of dippings was 577, of which 207 were redippings.

VENEREAL DISEASE OF HORSES.

Work in connection with the venereal disease of horses, the so-called maladie du coït, has progressed satisfactorily. During the annual round-up last year in the Indian reservations of South Dakota not one diseased animal or suspect was found; and, while careful and vigorous work has been continued through the year, no new case of the disease was discovered, either in the regular work or during the round-up in June. In view of these facts I have recommended that the quarantine maintained in this section be discontinued.

The work of stamping out the same disease in Van Buren County, Iowa, has likewise been successful. Reports from the quarantined area of Nebraska and South Dakota, included in the Pine Ridge and Rosebud Indian reservations, and portions of the counties of Fall and Custer, S. Dak., and Dawes, Sheridan, and Sherry, Nebr., show that 8,705 horses were inspected. One stallion and eight mares, all suspects, were slaughtered, for which $165, an average of $18.33, was paid. Nine stallions were castrated, for which $37.50 was paid, an average of $4.16. In Van Buren County, Iowa, 410 horses were inspected, 2 directly exposed stallions were castrated, and 12 directly exposed mares were slaughtered at a cost for those slaughtered of $565, or $47.08 each; these mares were breeding animals of a much better grade than those in the above-named territory of South Dakota and Nebraska.

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THE ARTIFICIAL CULTIVATION OF PROTOZOA.

The *Trypanosoma equiperdum* (the parasite which has been supposed to be the cause of the maladie du coït), which was referred to in the last report as having been imported from France in an inoculated dog, has not only been injected experimentally into various species of animals during the past year, but has been successfully grown on artificial culture media by the methods suggested by Novy and McNeal. Great difficulty was at first encountered in getting the original culture started, and numerous failures were recorded before the organism finally developed on a medium containing three volumes of defibrinated rabbit's blood to one of nutrient agar, a larger percentage of blood than is required for *Trypanosoma lewisi*. Subcultures have since developed with much greater ease and have now been cultivated artificially for over three months and to the fifth generation. The success that has followed the artificial cultivation of the trypanosomes naturally suggested the feasibility of growing other protozoa by the same or similar methods. An endeavor is now being made to find a medium suitable for the development of the *Piroplasma bigeminum* and *Plasmodium malariæ;* samples of blood containing them have been placed under what it is hoped will prove suitable conditions. The benefit to be derived from obtaining cultures of the Texas fever protozoan, for instance, can be readily appreciated when the possibility of thereby elucidating the life history of this parasite is considered, as well as the more important probability of so attenuating or controlling such cultures for the injection of susceptible animals as to produce a stronger immunity with less mortality than by blood inoculations.

MISCELLANEOUS WORK IN RELATION TO DISEASES OF ANIMALS.

During the past several years numerous specimens of tissue from various animals, principally from sheep and hogs, showing lesions of fat necrosis have been received at the pathological laboratory from the meat inspection force. Although this condition is quite distinct in its pathological picture and can be diagnosed with a fair certainty without the aid of a microscope, it seems to have caused some confusion as to the disposition of carcasses showing such lesions. With the object of reproducing the disease, as well as to attempt to ascertain its cause, a number of experiments on the dog and cat have been performed, and while the experiments are incomplete, the conclusion of previous investigators is confirmed that bacteria play no part, or at least are not essential, in the causation of the disease.

During the past year four specimens of pulmonary fat embolism in hogs killed at official abattoirs were forwarded for examination. In such cases the post-mortem reveals no other sign of disease, and yet here is a lung which at first appearance might be mistaken, sometimes for the lung of hog cholera, sometimes for that of swine plague. That this lesion does occur as a result of a fractured bone or the existence of an extensive destruction of the subcutaneous fat tissue has been proven; that it may occur in the less modern methods of hoisting and sticking the animals has been surmised. Further investigation is now in progress.

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Last fall attention was called to a disease affecting a number of young hogs belonging to the Reform School of the District of Columbia. Nine animals had died. The trouble proved to be paraplegia or paralysis of the hind quarters, so common in the hog raising districts of the Middle West. The point firing treatment was applied. This consists in making deep punctures with a hot iron about 2 inches apart over the lumbar region on either side of the spinal column, from 14 to 16 punctures being made in all. The treatment was successful, all of the 14 affected hogs recovering.

A number of cases of so-called avian diphtheria have been received for diagnosis. Among the different species represented were the chicken, pigeon, kite, and quail. Various organisms were found apparently in casual relationship with the disease; for instance, *B. necrophorus* in the kite, *Actinomyces bovis* in a chicken, and several other bacterial forms similar to those described by other observers in this field. The net result of the investigations of this disease (or group of diseases) compels the assumption that different germs must be charged with the early inflammatory disease, leaving the later cheesy or pseudo-membranous lesions to be instituted by such organisms as the necrosis bacillus, the agent of actinomycosis, and such other pathogenic forms, protozoal, bacterial, or mycotic, as may find easy lodgment in the diseased tissues of the mouth and upper air passages.

An interesting experience was the finding of the actinomyces in the pseudo-membranous patches in the mouth of a chicken affected with a complication of avian diphtheria and chicken pox. In making numerous cultures from these necrotic patches in an endeavor to isolate a pathogenic organism, a growth was obtained from the mouth lesions which on being plated furnished among other micro-organisms several colonies of actinomyces. About three months later in working on similar patches in the pharynx of a second chicken sent in for examination and not showing any evidence of chicken pox, another member of the laboratory force isolated an actinomyces which corresponded in every particular to that first recovered. There appears to be no reference in the literature to indicate that actinomyces had ever before been found in relation to avian diphtheria, nor in fact to any other disease of chickens. Scarifications made in the mouths of healthy fowls and rubbed with the spores of actinomyces produced an evanescent exudative process, and this fact coupled with the presence of the micro-organisms in the two different outbreaks appears to warrant a more extended investigation of avian diphtheria along this line.

After Dunstan and Henry and Peters and Slade had shown that prussic acid might be produced in sorghum and some other plants by the action of an enzyme upon a glucoside, the Biochemic Division began a number of examinations of cornstalks with the object of determining whether or not some instances of so-called "cornstalk disease" might not be due to prussic acid produced in the manner mentioned above. These experiments showed that an enzyme resembling "emulsin" was present in all cornstalks examined and that it was capable of splitting off prussic acid from the glucoside "amygdalin." In the cornstalks, however, no glucoside capable of yielding prussic acid could be found and examinations were made of other field plants and grain, with the results similar to those obtained with corn.

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The details of these experiments appear in the Annual Report of the Bureau for 1904.

Many specimens of parasites sent in by correspondents have been identified in the Zoological Division; about 500 specimens added and the entire collection—nearly 5,000 specimens—has been recatalogued after a new and more useful plan. In this Division, also, arrangements have been made for a set of experiments to determine, if possible, practicable preventive methods against the roundworms so prevalent and injurious to sheep in many localities; bulletins have been issued on the subjects of external parasites of hogs, gid in the United States, and on certain parasites of chickens and pigeons, two of which are species new to science; publication of the Index-Catalogue of Medical and Veterinary Zoology is continued, the G, H, I, and J authors having been issued.

POULTRY-FEEDING EXPERIMENTS.

During the past year more than thirty individual feeding experiments with chickens have been completed. The chickens used were kept under as healthful conditions as possible, new houses having been erected especially for the digestion experiments and so constructed as to afford ample ventilation and sunlight. There have been completed this year experiments with the single grains, corn, wheat, and oats, and some with mixtures of these three grains. In addition, green food was made a part of the ration in certain experiments. The chemical portion of these experiments is not yet complete.

EXAMINATION OF STOCK DIPS.

The requirements of the Department that the lime-and-sulphur dips when diluted ready for use shall contain not less than 2 per cent of lime nor more than 1 per cent of sulphur combined in the form of calcium sulphides have necessitated a chemical examination of all concentrated lime-and-sulphur dips of that character which are to be used for official dipping. The samples analyzed are purchased by inspectors of the Bureau in the open market. In addition, examinations of sulphur and nicotine solutions which are used in compounding the lime-and-sulphur and tobacco-and-sulphur dips were made.

The Beaumont crude petroleum having been found effective as a dip for destroying Texas fever cattle ticks, the Biochemic Division has received for analysis samples of crude petroleum from most of the recently discovered oil deposits in the western portion of the United States. Another form of stock dip which has received considerable study is that known as the "carbolic dip." In addition to the analyses, considerable research work has been done, which had for its objects (1) increase of efficiency of dips and (2) decreased cost of dips. These experiments lead to the hope that both of these ends may be accomplished.

GLANDERS.

During the past year 8,999 doses of mallein have been prepared in the biochemic laboratory and sent free of charge to authorized health officers in the various States, this being a considerable increase over the 7,197 doses sent out during the preceding year.

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Distribution of mallein to States and Territories.

	Doses.		Doses.
Arizona	24	North Dakota	712
California	726	Oklahoma	84
District of Columbia	1,966	Ohio	102
Iowa	310	Porto Rico	390
Kansas	132	Utah	66
Michigan	36	Vermont	48
Minnesota	3,012	Washington	314
Missouri	276	Wisconsin	27
Montana	720	South Carolina	6
Nebraska	42		
North Carolina	6	Total	8,999

AUTOPSIES OF WILD ANIMALS.

An investigation of the cause of death in all animals which died at the National Zoological Park during the fiscal year was made by the Pathological Division. No enzootic outbreak has occurred, the majority of deaths being due to gastral intestinal disorders, as a result of the unnatural conditions to which animals are necessarily subjected in captivity. Twenty-nine animals died of such disorders; tuberculosis was fatal to 12; pneumonia to 11, and helminthiasis to 16.

THE INSPECTION OF MEAT.

WHY THE SERVICE SHOULD BE EXTENDED.

In this connection it should be noted that there are numerous abattoirs killing hogs and other animals for the interstate trade where no inspection has been established, and where there are, consequently, no inspectors to condemn and remove the diseased carcasses. The inspection, which has been in operation for about fourteen years, has demonstrated beyond question that with the most careful buying of animals for slaughter there is found a considerable proportion so affected by disease as to be either actually dangerous to human health or offensive and unfit for human food.

Not only is there the large proportion of tubercular carcasses already mentioned, but there are numerous other diseases even more dangerous. In the year just closed there were found seriously affected with abscesses or pyemia 569 carcasses of beef, 230 of sheep, 70 of calves, and 4,044 of hogs—a total of 4,913 carcasses. There were found affected with enteritis, peritonitis, or metritis, 461 carcasses of beef, 191 of sheep, 59 of calves, and 994 of hogs—a total of 1,705 carcasses. There were also found affected with septicemia 239 carcasses of beef, 208 of sheep, 60 of calves, and 877 of hogs—a total of 1,384 carcasses. And, finally, there were found affected with hog cholera or swine plague 13,553 carcasses. In this group of acute septic diseases, which can not but be regarded as extremely dangerous to the health of persons using the affected meat for food, there were discovered and destroyed by the inspectors not less than 21,555 carcasses.

It is inconceivable that abattoirs having no inspection are able to avoid the purchase of animals so affected, and without expert inspectors it may safely be assumed that few of these diseased carcasses are detected. There is, consequently, an urgent need of inspec-

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tion at every abattoir, and as the Federal Government has undertaken to inspect all meat for the interstate and foreign trades, it should extend the inspection until this object is effectually accomplished.

For two years there have not been sufficient funds available to place the inspection at all the abattoirs from which application has been made for inspection, and there are numerous others for which no application has been made and where inspection is not desired by the operators. The absence of inspection at these places not only permits uninspected meat to go into interstate and foreign commerce, but it gives an opportunity for unfair competition with the establishments which have the inspection. For example, if one abattoir, as is the case at present, has inspection and loses 1½ per cent of its hogs by condemnation for tuberculosis, amounting in value to over $200,000 a year, and another abattoir doing a similar amount of business without inspection puts these diseased carcasses on the market on the same terms as healthy ones, it is plain that the profits of the latter will be $200,000 greater than those of the former, unless an advance in price can be obtained for inspected pork, which apparently is not the case with that sold in our domestic markets. A house without inspection can, therefore, undersell a house that has inspection, and, instead of encouraging inspection and making it to the interest of all abattoirs to have it, the tendency of the system of partial inspection now adopted by the Government is to place a burden on the houses which have inspection and to encourage others to operate without it. It is a matter of great importance, both for the protection of the health of our people and for maintaining the reputation of our meats, that the inspection should be extended promptly and made as thorough as possible.

WORK OF THE PAST YEAR.

During the fiscal year 1905 inspection was inaugurated at 7 establishments. Three of these had previously had inspection and 4 had not. Of the former number 2 had been rebuilt after having been destroyed and the other was an abattoir that was reopened by a new firm after having been shut down for about two years. During the same period inspection was, for various causes, not conducted at 5 establishments which had had inspection in the previous fiscal year.

In the following table are shown the number of establishments and the number of cities where inspection was conducted each fiscal year since 1891:

Number of establishments and cities where meat inspection was conducted, 1891 to 1905.

Fiscal year.	Number of establishments.	Number of cities.	Fiscal year.	Number of establishments.	Number of cities.
1891	9	6	1899	139	42
1892	23	12	1900	149	46
1893	37	16	1901	157	52
1894	46	17	1902	155	50
1895	55	19	1903	156	50
1896	102	26	1904	152	51
1897	128	33	1905	151	52
1898	135	35			

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The number of ante-mortem inspections of animals intended for slaughter and the number rejected on such examination are shown in the following table, and indicate an increase of 1,208,121 inspections as compared with the previous fiscal year:

Ante-mortem inspections for the fiscal year 1905.

Kind of animal.	For official abattoirs in cities where inspections were made.	For abattoirs in other cities and miscellaneous buyers.	Total inspections.	Rejected (subject to result of post-mortem inspections).	
				At abattoirs.	In stock yards.
Cattle	6,213,267	6,306,374	12,519,641	926	46,353
Sheep	8,023,659	6,795,627	14,819,286	1,558	9,702
Calves	791,650	591,537	1,383,187	961	11,817
Hogs	24,822,455	12,276,935	37,099,390	4,667	58,448
Total	39,851,031	25,970,473	65,821,504	8,112	126,320

The following statement shows the number of post-mortem inspections and the number of carcasses and parts condemned (exclusive of hog carcasses condemned for trichinæ):

Post-mortem inspections for the fiscal year 1905.

Kind of animal.	Number of inspections.			Carcasses condemned.			Parts of carcasses condemned.
	For official abattoirs.	On animals rejected in stock yards.	Total.	For official abattoirs.	Animals rejected in stock yards.	Total.	
Cattle	6,096,597	37,791	6,134,388	13,859	3,942	17,801	3,466
Sheep	7,872,671	6,302	7,878,973	4,900	1,351	6,251	2,973
Calves	845,802	4,425	850,227	2,224	2,229	4,453	75
Hogs	25,323,984	33,441	25,357,425	86,293	3,985	90,278	152,454
Total	40,139,114	81,899	40,221,013	107,276	11,507	118,783	158,968

While, according to the above statement, more post-mortem inspections were made in the past fiscal than in any previous year, reference to the comparative table on page 46 will show that the increase over 1904 was not up to the average. This was doubtless due to the very marked falling off in slaughtering done at the principal packing centers during the strike in 1904, this affecting the business of the first quarter of the fiscal year.

In addition to the regular and microscopic condemnations the following carcasses were tanked for reasons designated:

Animals lost otherwise than by disease.

Manner of death.	Cattle.	Sheep.	Calves.	Hogs.	Total.
Died in yards	831	872	290	1,698	3,691
Killed in yards	888	467	4,289	19,899	25,543
Died at abattoirs	359	2,149	290	14,387	17,185
Total	2,078	3,488	4,869	35,984	46,419

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The following table shows in detail the various diseases and conditions for which carcasses and parts were condemned and tanked during the year and also includes those found dead and those killed by city inspectors:

Causes of condemnation of carcasses and parts of carcasses, fiscal year 1905.

Cause of condemnation.	Cattle.		Sheep.		Calves.		Hogs.	
	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.
Actinomycosis	1,246	1,755	2		2	2	24	131
Tuberculosis	10,956	647	27		28		64,919	142,105
Caseous lymph-adenitis			988	1,922				
Cholera and swine plague							13,553	
Texas fever	229				148			
Echinococcus			1	196			5	1,248
Measles							11	
Scabies			3				49	
Eczema							3	
Erysipelas							37	
Cancer	56		2				8	
Tumor	7	5	4	1	1	1	445	321
Abscess	102	253	40	80	12	11	1,066	1,235
Pneumonia	261		322		21		1,147	
Pleurisy	15		26	31	4		120	10
Carditis			4					
Enteritis	52		85		22		304	
Peritonitis	327		73		36		535	
Metritis	52		33		1		155	
Nephritis	6		10		4		34	
Uremia	3		28		2		49	
Mammitis			2				4	10
Septicemia	239		208		60		877	
Pyemia	467		190		68		2,978	
Gangrene	14		5		8	16	19	
Anemia, emaciation, marasmus	1,945		2,876		350		643	
Ascites	14		32				52	
Jaundice	25		419		21		868	
Extreme temperature, various causes	3		67		3		1,785	
Pregnancy	56		26				173	
Recent parturition	53		13				46	
Hernia	1		1		1		21	
Downers, bruised, injured, etc	1,667	806	738	193	172	45	348	7,394
Dead from various causes	1,190		3,002		580		16,085	
Too young			1		3,483			
Killed by city inspectors	888		467		4,289		19,899	
Asphyxia	5							
Fistula					3			
Arthritis				1	1			
Blackleg					1			
Leucocythemia					1			
Pulmonary apoplexy			1					
Cysticercus tenuicollis			2					
Distoma			2	199				
Melanosis			1					
Flukes				87				
Cystic livers				263				
Total	19,879	3,466	9,701	2,973	9,322	75	126,262	152,454

The following statement shows, by years, the total number of the different classes of animals inspected post-mortem for official abattoirs since 1891, the total for the past year being greater than that of any previous year.

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Number of animals inspected at slaughter for abattoirs having inspection, fiscal years 1891 to 1905.

Fiscal year.	Cattle.	Calves.	Sheep.	Hogs.	Horses.	Total.
1891	83,889					83,889
1892	3,167,009	59,089	583,361			3,809,459
1893	3,922,079	92,947	870,512			4,885,538
1894	3,861,594	96,331	1,020,764	7,648,146		12,626,835
1895	3,704,042	116,093	1,428,601	13,616,539		18,865,275
1896	3,985,484	256,905	4,629,796	14,250,191		23,122,376
1897	4,242,216	273,124	5,209,161	16,808,771		26,533,272
1898	4,418,738	244,330	5,496,904	20,893,199		31,053,171
1899	4,382,020	246,184	5,603,096	23,836,943	3,332	34,071,575
1900	4,841,166	315,693	6,119,886	23,336,884	5,559	34,619,188
1901	5,219,149	413,830	6,639,212	24,642,753	1,992	36,916,936
1902	5,559,969	555,836	7,434,878	25,277,107	1,649	38,829,439
1903	6,134,410	668,855	8,585,960	21,793,738	344	37,183,307
1904	6,350,011	764,590	8,261,051	24,128,462		39,504,114
1905	6,096,597	845,862	7,872,671	25,323,984		40,139,114

The meat-inspection tag or label was placed upon 21,835,655 quarters of beef, 7,849,200 carcasses of sheep, 844,979 carçasses of calves, and 1,025,676 carcasses of hogs. Sacks of meat were sealed as follows: Beef, 5,793; pork, 795,171.

White stamps, indicating the regular post-mortem inspection, were affixed to packages of meat and meat products as follows:

Meat-inspection stamps.

	Packages stamped (white stamp).
Beef	7,123,506
Mutton	29,273
Veal	8
Pork	15,252,508
Total	22,405,295

The number of cars sealed containing inspected meat and meat products was 66,846.

In the following table are shown the interabattoir consignments of inspected meat and meat products; the receipts especially represent much labor on the part of Bureau employees, as all products of every kind entering an official establishment must be identified as having received inspection.

Interabattoir consignments of inspected meat and meat products.

Class of product.	Shipments to official establishments.		Receipts from official establishments.	
	Number quarters and carcasses.	Smaller pieces (weight).	Number quarters and carcasses.	Smaller pieces (weight).
	Quarters.	*Pounds.*	*Quarters.*	*Pounds.*
Beef	1,660,216	149,261,488	1,843,027	321,547,043
	Carcasses.		*Carcasses.*	
Mutton	18,887	5,675,988	20,451	2,206,678
Veal	28,437	1,169,293	1,627	4,651,738
Pork	54,589	371,340,413	25,097	345,900,758

INSPECTION OF EXPORT MEATS.

There were 36,097 certificates of ordinary inspection issued to cover meat and meat products for export, as follows: 1,216,077 quarters, 22,652 pieces, 20 carcasses, and 1,795,051 packages of beef, weighing

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361,012,062 pounds; 1,592 carcasses and 3,553 packages of mutton, weighing 206,570 pounds; 18,319 carcasses and 498,735 packages of pork, weighing 155,513,776 pounds; a grand total of 516,732,408 pounds.

The following statement shows, by years, the quantities of the different classes of meat for export under certificates of ordinary inspection since 1898:

Quantities of meat for export under certificates of ordinary inspection, 1898 to 1905.

Fiscal year.	Beef.	Mutton.	Pork.
	Pounds.	*Pounds.*	*Pounds.*
1898	339,650,091	324,996	244,956,482
1899	360,843,856	525,705	278,696,435
1900	438,138,233	680,897	272,050,603
1901	452,830,373	894,648	231,144,938
1902	416,990,762	1,145,248	188,360,011
1903	371,920,737	2,729,013	133,122,610
1904	419,058,781	712,089	154,442,440
1905	361,012,062	206,570	155,513,776

The large decrease in beef exports as indicated above was doubtless due to the strike previously mentioned.

The total cost of the work of ordinary inspection for the year was $829,532.36.

THE MICROSCOPIC INSPECTION OF PORK.

IMPORTANCE OF INCREASING MICROSCOPIC INSPECTION.

The microscopic inspection of pork for export during the year has been far less than the requirements of the trade, and with insufficient funds for the work already in progress it has been impossible to increase this branch of the inspection service. The understanding with Germany and some other European countries at the time the prohibition on American pork was removed required a microscopic inspection for trichinæ by this Government and a certificate to accompany the pork stating that such inspection had been made. For a number of years, however, the German Government has not accepted the American certificate as having any sanitary value, and has reinspected, at the expense of the shipper, all pork received there from the United States. Nevertheless, it has appeared desirable to continue the microscopic inspection in this country in order to reduce to a minimum the percentage of trichinæ found on reinspection in other countries. This is an important measure for maintaining the reputation of our meats, and one which this country can not afford to neglect. But if a microscopic inspection is required for pork exported to the continent of Europe, a sufficient number of inspectors should be furnished to inspect all the meat that is called for by the trade, so that the effect of this inspection will not be to shut pork into this country rather than to aid in getting it out. It is an injustice to American pork producers to enforce measures which obstruct and lessen the export trade, as has recently been done; and either there should be sufficient funds provided fully to accommodate the trade or this inspection should no longer be required.

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WORK OF THE PAST YEAR.

The number of hog carcasses examined for trichinæ was 346,026, classified as follows: Class A (free from all appearance of trichinæ), 336,623, being 97.28 per cent; class B (containing trichinæ-like bodies or disintegrating trichinæ), 5,666, being 1.64 per cent; class C (containing live trichinæ), 3,737, being 1.08 per cent.

The number of certificates issued for microscopically inspected pork was 1,960, covering 41,548 stamped packages, weighing 14,721,935 pounds, which, as will be seen from the comparative statement below, was an increase over 1904 of 5,701,414 pounds, being 63 per cent.

The number of trichinous carcasses disposed of was 3,652, weighing 819,922 pounds, 57 per cent of which was made into cooked meat products, the remainder, 43 per cent, being tanked.

The following comparative statement shows, by years, the quantity of pork exported to countries requiring microscopic inspection, from 1892 to 1905:

Quantities of pork exported to countries requiring microscopic inspection, fiscal years 1892 to 1905.

Year.	Pounds.	Year.	Pounds.
1892	22,025,698	1899	108,858,149
1893	8,059,758	1900	55,809,626
1894	18,845,119	1901	35,942,404
1895	39,355,230	1902	53,681,229
1896	21,497,821	1903	19,108,341
1897	42,570,572	1904	9,020,521
1898	120,110,356	1905	14,721,935

The cost of microscopic inspection was $56,313.02, being an average of 16.27 cents for each carcass examined, and 0.38 cent for each pound exported.

OUR COMPETITORS FOR THE BRITISH MEAT TRADE.

As our most important market for dead meat is found in Great Britain, it is interesting to consider the condition of this trade for a number of years as compared with the development of this trade from other countries. The material for this comparison is found in the annual statement of the trade of the United Kingdom for 1904, from which the figures used in the following tables are taken:

Quantities of dead meat imported into the United Kingdom from certain countries from 1900 to 1904, inclusive.

Country.	1900	1901	1902	1903	1904
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
Total imports of United Kingdom	17,438,576	18,372,564	16,519,565	17,022,482	16,983,788
United States	9,541,542	10,473,827	8,124,336	7,548,529	7,110,827
Argentina	1,612,456	2,152,283	2,412,923	2,821,930	3,327,841
Denmark	1,306,540	1,258,319	1,558,647	1,760,657	1,954,229
New Zealand	1,838,524	1,748,706	1,921,262	2,238,737	1,837,636
Canada	823,072	605,541	688,067	941,124	1,106,408
Holland	1,034,045	1,009,241	1,053,801	1,106,373	1,014,507
Australia	1,096,891	912,478	484,435	336,261	359,176

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This table indicates that the annual imports of dead meat into the United Kingdom have not varied greatly during the five years from 1900 to 1904. The imports from the United States show a decrease each year since 1901. From 1900 to 1904 the decrease has been 25½ per cent, and from 1901 to 1904 it has been 32 per cent. The imports from Argentina have increased each year from 1900 to 1904. The total increase during these years has been slightly more than 100 per cent. The imports from Canada have increased 34 per cent. The imports from Denmark have increased 49½ per cent. The imports from Holland and New Zealand have remained approximately the same, while those from Australia have decreased to about one-third of what they were in 1900. Our principal competitors in the British markets are, therefore, Argentina, Denmark, and Canada, each of which is rapidly increasing its trade, while our trade has been falling off.

By analyzing the trade more closely it is found that the only source from which our fresh-beef trade is threatened is the Argentine Republic. The imports from the two countries were as follows:

Imports of fresh beef into the United Kingdom from the United States and Argentina.

Country.	1900	1901	1902	1903	1904
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
United States	2,867,238	3,180,291	2,290,465	2,693,920	2,395,836
Argentina	412,262	771,929	923,748	1,152,211	1,675,271

This table shows that while the fresh-beef trade from the United States has decreased 16½ per cent from 1900 to 1904, that from Argentina has increased over 300 per cent. It also shows that whereas the trade of the United States has diminished 784,455 hundredweight since 1901 the trade of Argentina has increased 903,342 hundredweight in the same time. It is worthy of notice that in 1900 the beef imports from Argentina were but 14.3 per cent of those of the United States, while in 1904 they were about 70 per cent of those from this country. The shipments of fresh beef from Argentina are therefore rapidly gaining on those from the United States and our shipments are now falling off almost to the same extent as those from Argentina are increasing.

The bacon trade is one which is also worthy of special study. The following table shows the most striking figures on this subject:

Imports of bacon into the United Kingdom from certain countries.

Country.	1900	1901	1902	1903	1904
	Cwt.	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
United States	3,956,527	4,244,329	3,283,855	2,893,507	2,806,108
Denmark	1,094,626	1,060,909	1,255,627	1,496,101	1,723,884
Canada	529,864	808,697	462,487	665,249	829,883
Russia	5,655	27,168	34,721	45,964	41,918
Sweden	11,235	9,537	20,461	18,814	23,965

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This table shows that the imports of bacon from the United States have decreased 1,150,419 hundredweight, or 29 per cent, since 1900; while increases have been made by Denmark of 629,258 hundredweight, or 57 per cent; by Canada of 300,019 hundredweight, or 56 per cent; by Russia of 36,263 hundredweight, or 641 per cent; and by Sweden of 12,730 hundredweight, or 113 per cent.

The bacon trade is deserving of more attention than it has been receiving, for our natural conditions are such that we should be able to produce this article at a cost which would permit it to compete successfully for many years with any other part of the world. If we are producing a kind of bacon which does not fully meet the requirements of the trade, it would not be a difficult matter to change our type of hog sufficiently to comply with the demand. We should not, however, remain inactive while this important branch of our export trade declines and our commodity is gradually replaced by the product of other countries. There appears to be a more promising field for effort in Great Britain than in the markets of other countries, many of which are less favorable to our trade.

CONDITION OF THE OCEAN CARRYING TRADE.

The ocean carrying trade for live animals is one to which particular attention is invited, the number of clearances of vessels carrying live stock last year being 731. At the time the Bureau of Animal Industry was given supervision over this traffic, in 1891, with authority to regulate the fittings of steamships, the ventilation, the amount of feed carried, and the number of attendants, the losses were so heavy that the British Government was seriously considering the prohibition of the traffic because of the cruelty to which the animals were subjected and the bad condition in which many of them arrived.

The losses of cattle in transit had been very high, probably about 4 per cent, although exact figures are not obtainable, and on sheep they were somewhat higher. The first year the regulations went into effect the losses of cattle were reduced to 1.6 per cent and the losses of sheep to 1.7 per cent. This loss has been further reduced from year to year until during the year just closed it was but 0.138 per cent for cattle and 0.751 per cent for sheep; that is, the losses on cattle were reduced the first year of the Bureau control to about one-half what they had previously been and since that time they have been reduced to one-eleventh of what they were the first year. Similarly, the losses of sheep were reduced more than one-half the first year, and have been further reduced to less than one-half of the first year's figures. The insurance has been reduced from 8 per cent to one-third of 1 per cent—that is, to one twenty-fourth of the rate formerly charged—thus saving in this one item much more than the total appropriation for the Bureau of Animal Industry.

INSPECTION OF EXPORT ANIMALS.

The number of certificates of inspection issued during the year for American cattle exported to Europe was 1,269. The following statement, showing the number of live animals exported, indicates, when compared with the similar statement for the previous year, a falling

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off of about 5 per cent in the number of American cattle, 31 per cent in the number of American sheep, and 28 per cent in the number of American horses exported.

Number of inspections, etc., of American and Canadian animals for export, fiscal year 1905.

Kind of animal.	American.				Canadian.		
	Number inspected.	Number rejected.	Number tagged.	Number exported.	Number inspected.	Number rejected.	Number exported.
Cattle	783,721	2,850	409,101	[a]395,695	41,193	12	41,181
Sheep	366,796	114	.....	[b]183,902	56,984	32	56,952
Horses	2,327	1	1,974	2,061	31	.....	31

[a] 24,915 via Canada. [b] 6,302 via Canada.

All animals included in the foregoing statement were exported to Great Britain except 5,452 cattle, 2,074 sheep, and 97 horses to Belgium, 3 cattle and 142 horses to France, 21 cattle to South Africa, 131 horses to Germany.

In addition, other animals were exported as follows: 2,347 cattle, 2,465 sheep, 23 horses, 265 swine, and 6 mules, making a total of 5,106, destined as follows: 1,595 cattle, 1,941 sheep, and 12 horses to Bermuda; 700 cattle to Brazil; 445 sheep to Barbados; 10 cattle, 7 horses, and 5 swine to Argentina; 20 cattle, 4 horses, 6 mules, and 260 swine to Hawaii; 22 cattle to Mexico, and 79 sheep to West Indies.

Statement showing number of animals inspected at time of landing in London, Liverpool, and Glasgow, and loss in transit, fiscal year 1905.

From—	Cattle.			Sheep.			Horses.		
	Landed.	Lost.	Per cent of loss.	Landed.	Lost.	Per cent of loss.	Landed.	Lost.	Per cent of loss.
United States	368,648	508	0.138	178,236	1,348	0.751	1,680	9	0.533
Canada	32,975	103	.311	54,689	1,157	2.072	30	.....	.....
Total	401,623	611	.152	232,925	2,505	1.064	1,710	9	.524

In comparing the above statement with the preceding one, in which the numbers exported are shown, it is necessary to remember that many of the animals included in the former statement are not included in the latter, because they were landed at British ports, where no Bureau inspector is stationed, and hence are not reported from the other side.

IMPORTS OF DOMESTIC ANIMALS.

THE DANGER OF IMPORTING DISEASE.

There is always danger of importing the contagion of one of the Old World plagues which have been so destructive to live stock in Europe, Asia, and Africa. With faster ships and increasing traffic this danger is greatly augmented.

There is at present foot-and-mouth disease in Europe, Asia, and South America; rinderpest in Asia and Africa; pleuro-pneumonia in

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Asia and Africa; and a variety of infectious diseases unknown to this continent which are destroying the farm stock in other sections of the world, and particularly in Asia and Africa. We are in especial danger from the Philippine Islands, where foot-and-mouth disease, rinderpest, and surra are known to exist, and from which it is very difficult to exclude all animals.

Our system of inspection and quarantine has been developed to a high state of perfection and gives great protection on the Atlantic coast, but the Pacific coast needs quarantine stations, and with continued traffic in susceptible species of animals there will always be the possibility of bringing contagion even with the most careful inspection.

It should be the policy of any country having such tremendous investments in live stock as have been made in the United States to exclude so far as possible all animals liable to harbor the contagion of the plagues most destructive to the meat-producing animals. There are few who appreciate the vast losses which such plagues cause or their effect upon the prosperity of a country. Either rinderpest or foot-and-mouth disease, if allowed to spread over this country, would cause a loss of three hundred millions to five hundred millions of dollars during the first two years, and might remain to prevent the recovery of the cattle industry for an indefinite period. The damage would be felt not alone by the agricultural industry, but by all citizens, and particularly by the laboring classes and by the poor of our cities, to whom such a limitation of the food supply would mean great hardship and suffering. It is of supreme importance, therefore, that great care and watchfulness be exercised to exclude contagion, and that this supervision be maintained over dogs, which may bring surra, and menagerie animals, which may bring rinderpest, foot-and-mouth disease, surra, and pleuro-pneumonia, as well as over farm animals.

IMPORTATIONS DURING THE YEAR.

The imports of pure-bred cattle, sheep, and hogs during the year have continued light. Those quarantined at the several quarantine stations are as follows:

Number of cattle, sheep, and swine imported and quarantined.

Port of entry.	Cattle.	Sheep.	Swine.
New York	223	259	9
Boston	4	89	7
Baltimore	42	68	16
Canadian border ports	127	86	84

Animals imported from Canada, not subject to quarantine.

Cattle	2,642	Asses	11
Sheep	84,272	Goats	1
Swine	2,012	Deer	2
Horses	3,108	Lions	3
Ponies	26		
Mules	2	Total	92,081
Burros	2		

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Imports of horses, mules, donkeys, and asses through ports on the Atlantic and Pacific coasts amounted to 2,642.

QUARANTINE ISLAND.

There has been in the past few years a growing demand for an isolated point directly accessible to ocean steamers, or by barge, where animals may be quarantined safely, even though from a country where foot-and-mouth disease prevails. In June such a place was brought to the attention of the Bureau. This land is located on the Fresh Kills, a tributary of Staten Island Sound, and is known as Simonson's Island, comprising about 28 acres of upland, and is separated from the mainland of Staten Island on its land side by a ditch and wide expanse of salt meadow. An agreement has been made with the owners of the island and of a dock on the New Jersey side of Staten Island Sound, having connection with two railroads that may be used for shipping animals to destination when released from quarantine. This agreement gives the Bureau control, with but slight expense, as the owner will accept as rental or compensation a per capita fee, to be paid by importers, who will also, in accordance with the rule governing the quarantine of animals, pay for necessary feed, bedding, and animal attendants.

PRINCIPAL QUARANTINE STATIONS.

At the quarantine station for the port of New York, located at Athenia, N. J., the improvements on the grounds have progressed satisfactorily, and the work of grading yards and roads has advanced to such a degree that the whole property, consisting of 53 acres, presents an attractive appearance and is equipped in a thoroughly modern manner. At the station for the port of Boston eight of the best and most conveniently located stables have been thoroughly repaired and painted.

Animals imported from Mexico, fiscal year 1905.

Port of entry.	Cattle.	Sheep.	Swine.	Goats.	Horses.	Mules.	Asses.	Burros.	Deer.	Total.
San Diego, Cal	256	4,740	1	3	112	17	62	4	.....	5,195
Calexico, Cal	1,467	.....	.....	.....	23	53	.....	.....	.....	1,543
El Paso, Tex	9,459	.....	1	2	9	.....	2	.....	.....	9,473
Eagle Pass, Tex	.....	.....	.....	202	9	5	1	.....	10	227
Laredo, Tex	.....	.....	.....	.....	12	39	.....	.....	.....	51
Nogales, Ariz	11,828	1	10	.....	103	26	18	.....	1	11,987
Total	23,010	4,741	12	207	268	140	83	4	11	28,476

Inspections were also made of animals imported from Mexico in bond, as follows: At El Paso 3,172 cattle, 486 sheep, 30 horses, and 49 swine, in transit to Mexico; 902 cattle, 820 horses, 81 mules, and 23 asses, in transit to Canada; 364 mules, in transit to South Africa; at Laredo, Tex., 3 horses and 96 mules in transit to Cuba, and at Calexico, Cal., 133 American horses and 146 American mules returned from work on irrigation canal and railway in Mexico.

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THE EXPERIMENTS IN FEEDING AND BREEDING.

The experiments in feeding and breeding, in cooperation with the State experiment stations, first provided for in the appropriation bill for the year just ended, open a field of work which, if wisely directed, should prove of the greatest value to the American stock raiser. There are many problems of this kind which urgently need solution, and perhaps there is no section of the country where the early investigation of feeding and breeding problems promises more for the welfare of agriculture than in the Southern States. The problems of the Southern stock grower are peculiar to his section, and can only be solved by experiments conducted in that section and under the conditions which there prevail. It is necessary to learn how the best breeds of cattle and sheep may be developed and maintained in the South without paying a too heavy tribute to the insect pests and parasites which find peculiarly favorable conditions for multiplication in the mild climate of that region. There is no doubt that much can be accomplished toward making the live-stock industry of the South more profitable, and the probability is that the great obstacles which have heretofore existed, such as the cattle tick (*Rhipicephalus annulatus*) and the internal parasites of sheep and cattle, may be brought under control, while the feeding problems may be elucidated with comparative ease.

Breeding problems exist in all parts of the country, and the farmers need especially to be assisted in developing our breeds to the highest efficiency and in fixing the types of highest excellence. Our conditions are such that the stock raisers of this country have not developed, established, and maintained distinct types of animals from our native stock, as has been the case in some other countries; and in cases where marked progress has been made toward this object the herds and flocks have been dispersed just at the time when they gave promise of future usefulness.

We have been depending too much upon the constant importation of breeding stock to keep up the excellence of our animals, and have introduced new types in our herds so frequently that the power to transmit the parents' qualities to the offspring has not been properly developed and, as a result, the animals do not breed as true to type as they should.

It consequently appears necessary that the Government should aid in such work, if there is to be sufficient permanence and singleness of purpose in the efforts to achieve success; but whether the required continuity of purpose and permanence can be secured even through Government aid is a question which only the future can answer. The importance of the matter is such, however, that it is well worth the experiment, even at considerable cost.

Several lines of investigation are in progress. The poultry-breeding work in Maine is proceeding and will be continued until definite results are reached. At the Pennsylvania Experiment Station experiments are continued with the respiration calorimeter in the study of animal nutrition. In Alabama a steer-feeding experiment has been conducted, the results of which seem to indicate that small amounts of cotton-seed meal and corn-and-cob meal were of equal feeding value, that the introduction of corn into the customary

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cotton-seed meal ration was not advantageous, and that cotton-seed hulls, corn stover, and coarse sorghum hay have about equal feeding value.

Under the contract with the Colorado Experiment Station 6 mares were purchased in Wyoming, 12 in Chicago, and 1 stallion in Chicago. The Wyoming mares were selected from a large band of horses which were bred up from stock brought in from States farther east, and which carried considerable Morgan blood. The mares and stallion purchased in Chicago vary considerably in their breeding; all, however, are trotting bred, and some of them standard bred. The object of these experiments is to increase the tendency which the trotting horse possesses, to develop large, strong, well-made animals, the best of which will answer every requirement of the horse show for heavy harness horses, and the average of which will meet the demand for a good, general-purpose horse.

NEW INVESTIGATIONS.

The following new lines of cooperation have been arranged for: At the Storrs Experiment Station, in Connecticut, investigations will be started in milch-goat breeding with foundation stock brought from abroad. At the Rhode Island Experiment Station studies will be begun in breeding turkeys resistant to infectious entero-hepatitis. In cooperation with the Maryland Experiment Station and the National Zoological Park experiments will be begun in breeding hybrids between the zebra and the mare. Six farm mares have been bought and will be bred to the Grevy zebra presented to the President by the Emperor of Abyssinia. This animal stands 13.2 hands and is strong and well built.

SUPERVISION OF PEDIGREE-RECORD ASSOCIATIONS.

A closer supervision over pedigree-record associations has been brought about and regulations upon the subject published as B. A. I. Order 130, dated October 14, 1904. These regulations require from each certified American association an annual report, the publication of books of record, and their submission to the department on publication. The associations must submit complete sets of the published volumes of their books of record, and complete statements of their business methods and financial condition. Foreign associations are obliged to keep complete sets of their books on file with the Department. Books of record are now certified as follows:

	American.	Foreign.
Cattle	14	31
Horses	17	23
Asses	1	2
Sheep	21	13
Hogs	13	2
Dogs	1	4
Cats	2	
Total	69	75

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MILCH GOATS.

During the year the Bureau has taken up the project of the establishment of the milch-goat industry in this country. In Europe this is an important and profitable interest, while in this country it amounts to but little. It is recognized that could the industry be established here it would benefit several classes of citizens, particularly that large number of families in modest circumstances living in the outskirts of cities, and unable, by reason of the limited ground space available, to keep cows. The milch goat is hardy, subject to few diseases, and requires but a small amount of food as compared with the cow; the milk is produced in large quantities, when the size of the animal is considered, and has peculiar value as food for children, convalescents, invalids, and those suffering from tuberculosis or other wasting diseases. The manufacture of cheese from goats' milk annually brings thousands of dollars to many communities in the Old World.

Recognizing these facts, the Bureau has labored to arouse and stimulate popular interest in the milch goat. The publication of a bulletin (No. 68) served this purpose. Following this, Mr. George F. Thompson, editor of the Bureau and author of the bulletin, was sent to Malta to bring a number of the best milch goats from that island. Upon their arrival in this country these animals will be placed at the experiment station at Storrs, Conn., where, in cooperation with the authorities at the station, the Bureau will conduct experiments to determine their adaptability to climatic and other conditions of this country, and to ascertain the value of their milk, particularly in the manufacture of cheese and as a food for the sick.

WORK IN THE INTEREST OF THE DAIRY.

During the past year the Dairy Division of the Bureau, in addition to the routine work, has carried on experiments so far as possible with the means at its command. The magnitude of the dairy interest and the improvement that would result to it by the solution of a number of questions which can be solved only by a long-continued experimentation make it seem best, in the report submitted below, to give more prominence than usual to the mention of features of work which, as soon as possible, should be taken up.

RESEARCH WORK IN PROGRESS.

MANUFACTURE AND STORAGE OF BUTTER.

One of the pertinent questions in relation to this topic is that of the control of the amount of water, salt, casein, and fat which butter contains. Creamery men desire to work all moisture possible into the butter, while Bureau of Animal Industry Order 127 makes it necessary to consider butter as adulterated which contains more than 16 per cent moisture. Very few butter makers know how to regulate the amount of moisture, and this fact, with the tendency in butter contracts toward a specification as to the amount of moisture (butter packed for the Navy must have less than 13 per cent), creates an

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urgent demand for a short method of determining moisture in butter. The accurate chemical methods require too much time, and are not within the reach of the practical butter maker in the field.

A peculiar development in the large quantities of butter annually stored, and one which causes a loss of thousands of dollars, is the fishy flavor. The cause of this and of the other undesirable flavors which develop should be sought out and corrected.

Temperature is another thing which should be carefully studied, as it is yet undetermined just what temperatures are best for cold storage.

The effect of the amount of moisture on the keeping quality, the effect of the amount of salt, and the result of the presence of a large quantity of casein are practical and difficult questions the solution of which will require a long time and the services of the best men obtainable. The exact cause of fine flavors in cream, the question of the pasteurization of cream, the question of the farm separator, and its effect on quality, are all pertinent problems. The introduction of the farm separator has lowered the standard of creamery butter, and this fact must be met by an improved system of handling and manufacture. Centralization of the creamery business into large churning plants has given rise to unsolved problems of the transportation of cream from long distances, and the introduction of a better line of machinery.

Recently C. E. Gray, formerly chemist and expert for a large centralization plant, was employed as an expert to study these questions. L. A. Rogers, bacteriologist in the Dairy Division, was associated with him, and the work has been taken up in cooperation with the Iowa Experiment Station at Ames, Iowa. Professor McKay will be directly connected with the investigations. During the summer (1905) several thousand pounds of butter were placed in storage in Chicago, where excellent storage facilities in especially constructed rooms were turned over to the Dairy Division for its sole use. Here the butter is stored at 32° and 10° F. above zero and 10° below. A parcel of cream was divided equally—one part being pasteurized and the other part churned without pasteurization. Half of each lot of butter was salted normally and half with a higher percentage. Some of each lot was packed in 3-pound tins and the rest in 20 and 30 pound tubs. Some investigations have been made in Wisconsin as to the fishy-flavored butter in evidence in that State.

EXPERIMENTS IN CHEESE MANAGEMENT AND STORAGE.

Although in some respects more work has been done in the manufacture of cheese than in that of butter, there are many points that require investigation. Naturally the commercial tendency is to force greener cheese upon the consumer. This fact makes a study of the early ripening important. The questions of using more rennet, of incorporating more moisture, and of making a softer grade have a direct bearing on the time when the cheese is edible. There is need also for study into the question of flavors and their causes, the effect of pasteurizing the milk, the digestibility of various types of Cheddar cheese; and a systematic effort should be made to encourage a greater use of cheese by the American people, inasmuch as this country consumes less per capita than any other.

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C. F. Doane, formerly dairyman and bacteriologist for the Maryland Agricultural College, has been appointed an expert in the Dairy Division for the study of these problems, and a cheese factory in Wisconsin selected as the place where a series of experiments on the lines indicated will be carried on.

Cooperation with the laboratories of the Department has been established so that samples of cheese of different ages may be artificially digested and analyses made, and experiments with this cheese on human subjects is also planned.

SOUTHERN DAIRYING.

The South presents many problems in dairying peculiar to that section. At present the South is supplied with dairy products almost entirely from Northern States. Condensed milk, cream, and butter, and practically all the cheese consumed, are from the North, while the Southern farmer devotes practically his whole attention to raising cotton. This cultivation of cotton upon the same fields year after year rapidly exhausts the soil, which must be restored by the use of commercial fertilizers at high prices. The great need of all this section is live stock; and dairy cattle should be among the first live stock introduced. The South can produce greater quantities of feed at less cost than can any other section of our country, but the lack of knowledge regarding the handling, care, and feeding of dairy stock and the kinds of crops to grow is the great drawback, and one with which the Dairy Division should be in a position to cope, both by sending its own men directly to the farms, and by cooperation with the State experiment stations and with State dairy organizations.

To study these questions, B. H. Rawl, dairyman at the Clemson Agricultural College, South Carolina, has been appointed as an expert. His work thus far has been to travel from point to point, studying the field and lending what encouragement he can to those who desire to go into dairying. Mr. Rawl has met with an enthusiastic reception, and he should be given several assistants, as hundreds of farmers have already shown themselves anxious for information and guidance. At Easley, S. C., a number of men have organized a cheese factory, and through the efforts of Mr. Rawl have been induced to build silos. Great interest is taken in the work by other dairymen in the South, many having indicated a desire to go to Easley and learn the methods, and it is expected to make this an objective center for dairy information. The establishment of other similar points for the diffusion of information in all the States would undoubtedly be attended with good results.

EXPERIMENTS IN THE MANUFACTURE OF EUROPEAN VARIETIES OF CHEESE.

Nearly all the cheese consumed in this country is of the Cheddar and Swiss varieties. In Europe, however, many fine varieties of cheese are made with which the average American is entirely unfamiliar, but the manufacture of which is very desirable in this country, inasmuch as the methods are simple and little machinery is required. Professor Clinton, director of the Storrs Experiment Station, with

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this end in view, began an investigation, but, encountering many difficulties, he called upon this Department for assistance and three men were detailed to work under his direction along these lines. During the past year most of the time has been given to the Camembert type of cheese, and the work has been quite successful. Bulletin No. 71 has been published, detailing the difficulties and showing that it is possible to make this cheese in the United States. Another bulletin is in preparation which will give specific instructions for manufacture. The experimental work at present is on the Roquefort type, and complete information will soon be available to the public regarding details of manufacture and the difficulties that beset the average maker who desires to enter this line.

THE CITY MILK SUPPLY.

This live and important subject is receiving more attention in many cities to-day than any other special feature of dairying, but it has been practically neglected by the experiment stations. The milk supply of cities is a serious question, and the problems in connection with it urgently demand investigation and solution. The Department has numerous calls for information and assistance, and it should be in a position to supply men who could go from place to place to study the laws of municipalities regulating milk supply, to give lectures to the people as to what they should demand in the way of pure milk, to investigate sources of the supply with special reference to the sanitation of barns and premises, and to inform producers as to the best methods. The value of pasteurization should be studied both in the field and the laboratory, as well as the methods of the producers of what is called "certified" milk. In connection with transportation, the principles of refrigeration, proper vessels for the milk in transit, receiving by railroads, and the several methods of distribution are all questions which should be investigated and information regarding them obtained and spread. Frequent application is made to the Department for information as to regulations of the various municipalities on these subjects, and a compilation of such regulations would be a convenient document.

The publication of one bulletin, No. 70, on the milk supply of 29 Southern cities, and the preparation of one bulletin on the milk supply of Philadelphia, New York, and Boston practically cover the work done by the Bureau on this subject during the past year.

DAIRY HUSBANDRY.

The fact that 50 per cent of the registered stock in dairy herds of this country should be regarded as scrubs because of low production shows that something along the line of breeding should be undertaken upon a broad and comprehensive basis, such as has been done, for instance, in the breeding of plants. As special lines along which such work might profitably proceed, the following may be mentioned: A study of the adaptability of the different breeds to different localities, involving questions of climate, character of country, and feed conditions; investigation of the perplexing question of whether or not the so-called "dual purpose" dairy animal is or can be made more profitable for certain sections than other types; encouragement of the

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use of ensilage and other coarse feeds; a study of how much grain—the most costly part of the cow's ration—can be replaced by these cheaper feeds; a study of the amount of concentrated feeds that can be fed without injury; the effect of feeding the by-products of distilleries and breweries—in short, the whole question of the effect of feeds on the quality of all dairy products; questions of breeding the proper time and season, the methods of handling breeding stock, shelter, exercise, cleanliness, the feeding of young stock; a systematic line of work in various States, whereby farmers might be induced to keep books of record showing quantities of feed eaten and the amount of product secured, so that unprofitable individuals may be thrown out of the herd. In these lines a vast improvement would result could the work be taken up and prosecuted by the Bureau. Investigation should also be made of the principles underlying the mechanism of farm dairy machinery, and the information obtained should be made public; an endeavor should also be made to secure plans and specifications of the best buildings for dairy purposes.

During the past year very little work has been done by the Bureau along these lines. Two bulletins have been prepared showing great numbers of records of individual animals and of dairy herds, and an investigation of a milking machine, largely from a sanitary standpoint, is now in progress. It can readily be seen, therefore, that there is room for considerable expansion.

RESEARCH WORK CONTEMPLATED.

CREAMERY AND CHEESE FACTORY MANAGEMENT.

Aside from answering correspondence nothing has been done by the Dairy Division on this subject, yet the field is broad and the possibilities great. For instance, upon the introduction of the factory system of manufacturing butter and cheese this country was thought to be a good place to employ the cooperative plan, and many such factories were established. Hundreds of these organizations have been failures. Among other concerns in the business there have also been many failures. These are not due to lack of business capacity, but to a lack of knowledge of the exceedingly numerous and sometimes obscure details of dairy work. Again, the tendency is now toward centralization in the creamery business, and this is looked upon by the producers with considerable misgiving. Could not the Dairy Division of the Bureau profitably investigate these matters and give out accurate and definite information as to the management of creameries? Persistent effort should also be made to induce manufacturers to make such dairy machinery as can be easily kept in a sanitary condition. Makers do not now seem to realize the importance of this point. For the benefit of small concerns investigation should be made as to the kind of equipment necessary to be used, so far as the principles of construction are concerned, and as to cold storage and the disposition of sewage. Important, also, especially where the centralization system has been adopted, is the problem of the transportation of milk and cream to the factory and of the manufactured product to the consumer, and any light thrown on this point would be welcomed both by manufacturers and by the railroads.

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INSPECTION OF DAIRY PRODUCTS IN THE MARKETS.

From one-half to three-fourths of the butter that comes to the great markets will not score as "extras," which means that it is not a good quality of butter. Inquiry among butter dealers and officials of State dairy organizations, dairy schools, and State dairy commissioners, leads to the belief that the Bureau, through the Dairy Division, has here a great field for operation. Competent men should be placed in the large markets to score the poorer grades of butter as they come in and report back to the particular State and creamery. The continued shipment of poor goods might be met by sending an expert from the Bureau or from the State to the creamery to study the reasons and to give instruction. The same possibilities are open in the cheese business, though perhaps to a less extent. Thus far the Bureau has done nothing along such lines. In connection with the plan proposed something should be done also toward studying conditions for foreign countries. The Dairy Division has to a limited extent attempted to export butter abroad, but the knowledge gained has not been practical. A thorough study of the conditions and requirements of foreign markets where our butter is likely to find sale would be a benefit.

DAIRY PRODUCTS OTHER THAN BUTTER, CHEESE, AND MILK.

This is another field in which the Bureau has done practically nothing. The manufacture of ice cream is a great industry, but much of the ice cream placed on the market is inferior in quality. The Department should be in position to investigate this question with a view to improvement. The manufacture of condensed and evaporated milk should also be studied. Experiments should be carried on in the manufacture of skim-milk cheese in order to determine if a cheese of this character should not be placed on the market, so that those who are forced to economy may be able to buy a product that is both cheap and wholesome. Numberless food products made in whole or in part of casein of milk should be investigated. The use of milk products in the arts could be studied with profit, and there should be wide experimentation to find profitable outlets for the skim milk and whey of creameries and factories. The use of buttermilk as a drink should receive attention and means be devised to put this wholesome product more generally on the market.

DAIRY STATISTICS.

The need of information of this kind is aptly shown by the speculation as to the cause of the high prices of dairy products during the past winter. Shortage of production, the effects of the oleomargarine law, a greater relative increase in consumption than production, etc., were all alleged as reasons, but satisfactory information was not obtainable. During the storage season buyers who would put butter in storage can not know how the make of the particular year compares with that of previous years. This has a bad effect on prices. These subjects, along with those of the quantities of dairy products manufactured in the country, the quantities put in storage for future consumption, and the amounts of exports and imports, all seem to be

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proper questions for investigation by this branch of the Bureau. The only work thus far done is the publication of figures based on the Eleventh and Twelfth censuses, and there has been a large demand for these publications.

INDEXING AND CLASSIFYING DAIRY LITERATURE.

No comprehensive index of dairy literature exists in this country. Information on any dairy topic is obtained only by an examination of numberless books and pamphlets. The great mass of literature should be indexed and classified, including the current literature, so that all the knowledge on any branch of the subject might be easily and quickly made available at any time.

INSPECTION WORK.

INSPECTION OF RENOVATED BUTTER.

Under the law of May, 1902, and the regulations of the Department made in accordance therewith, regular inspection of renovated butter plants has been carried on during the year by inspectors appointed for that purpose. Reports of such inspection on file in the Dairy Division show a tendency among makers to conform to the rules and to endeavor to improve the quality of their goods. The duties of the Bureau inspectors have included a thorough sanitary inspection of plants, inspection as to marking and packing of goods, and inspection of export renovated butter. Inspectors have reported few violations of the rules on the part of manufacturers, but this, unfortunately, is not true of dealers selling renovated butter. Many of the latter have contended that they have a right to remove all marks from such goods and to sell them for whatever they please. A recent decision in the United States district court of southern New York has sustained in every particular the rules and regulations of the Bureau as set forth in Order 127. This decision has been appealed by the defendants to a higher court, and a final decision will probably be reached during the coming winter.

The total amount of renovated butter made during the twelve months ending June 30, 1905, was 60,164,783 pounds, as compared with 54,171,183 pounds made during the twelve months ending June 30, 1904. The demand for all grades of butter was so great during the past year that all the packing stock available was used by the manufacturers, and there is, consequently, little old stock now used. In this line it is recommended that experiments be taken up to improve the general quality of the product. Renovated butter is a legitimate article of food, and it is not the policy of the Department to destroy its manufacture or its market, but to enforce the law which has for its purpose the protection of the consumer against fraud. The consumer could aid in this if he would in all cases ask whether or not the butter sold him is renovated. He could be assured that butter bearing the Government renovated stamp was made under sanitary conditions, and from goods containing nothing deleterious to health.

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REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., September 20, 1905.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1905.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON, *Secretary.*

BUSINESS OPERATIONS.

The appropriations for the Bureau of Plant Industry for the fiscal year ended June 30, 1905, amounted to $906,773.40. Of this sum, $129,893.40 is from a special appropriation made for the purpose of meeting the ravages of the cotton boll weevil. Approximately 40 per cent of the total appropriation was expended for administrative work and 60 per cent for strictly scientific work. Of the amount expended for scientific work approximately 30 per cent was for laboratory work in Washington and 70 per cent for field and laboratory investigations outside of Washington. It is difficult to state exactly the relative cost of administrative work and scientific work because many, if not most, of our men are engaged in both kinds of work.

During the year 3,940 requisitions were issued, 8,247 accounts were received, audited, and paid, 167 requests for contracts were made, and 469 letters of authorization were drawn. The matter of keeping correct records of all the financial operations of the Bureau has been given considerable thought and attention during the year. The nature of the work, involving as it does many varied problems, all of which must be properly financed, calls for strict and systematic attention to the details of expenditures. Difficulties in properly handling these matters have been met with for the reason that the work of the Bureau is widely scattered in separate buildings. In the operations of each office it is essential and necessary to be able to determine quickly the status of any account, authorization, or appointment involving payment of salary or other expenses. With a view to thoroughly systematizing the business operations of the Bureau, all work connected with the handling of accounts has been centralized. Following is a brief outline of the system of accounting as now practiced in the Bureau:

(1) FILES.—A complete file of papers showing authority for and details of expenditures, such as appointments, authorizations, requisitions, vouchers, etc., is provided for, each paper to be given a serial number and filed numerically.

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(2) ACCOUNT CARDS.—An account to be kept on cards, 5 by 8 inches in size, for each line of work or class of expenditure, each account to be designated by number, there being a separate series for each appropriation. Each set of cards for an account to bear the number of the account and to contain a card or cards for each of the following items of expenditure:

Salaries.	Freight.
Authorizations.	Telegraph.
Requisitions.	Telephone.
Contracts.	Rent.
Express.	Gas and electricity.

As details of every transaction are set forth in full on the file papers, only names, dates, amounts, and number reference to file papers will be entered on cards.

(3) ALPHABETICAL CARD INDEX.—An alphabetical card index to both accounts and file papers will be kept, showing the name of every payee, the number of his account, and the number of the file paper containing data concerning him, so that any particular item of information shown by the files or accounts can be found at once and with certainty.

(4) ACCOUNTING.—

(A) As soon as a paper authorizing an expenditure is received a liability entry will be made directly from it to the proper account card, an index card will be prepared, and the paper numbered and filed.

(B) When the voucher (in triplicate) is received, the paper authorizing the expenditure will be withdrawn, a charge card substituted showing date and by whom taken out, and the papers, strapped together, will go to the auditor. As soon as audited, the original duplicate vouchers will be passed without further delay, and the retained copy of voucher and file paper will go to the bookkeeper for entry of expenditure, thus completing the record of the transaction.

(5) CHECKING.—

(A) The auditor will have desk memorandum cards numbered to correspond with the accounts and ruled with a column for voucher number and a column for each item of expenditure. As soon as a voucher is audited he will note its number and amount in the proper columns of his memoranda.

(B) The following morning the entries on the auditor's memoranda and the entries on the account cards will be checked against the retained copy of voucher to insure their accuracy.

(C) At the close of the month the total expenditure shown by the account cards of the bookkeeper will agree with the totals shown by the auditor's memoranda. If not, the error can be readily located.

(6) FINANCIAL STATEMENTS.—At the close of the month the several accounts will be summed up on an adding machine and the totals typewritten in triplicate on printed forms of financial statement or summary cards, provision being made for monthly, quarterly, and annual statements. These statements or summaries will be of three kinds:

(A) *Account summaries*, showing status of each account; one copy for the accountant, one for the head of the office having charge of the expenditure of the appropriation, and one for the men in charge of the particular lines of work to which the accounts relate.

(B) *Appropriation summaries*, consolidating the totals of the account summaries; one copy for the accountant, one for the heads of the various offices, and one for the Chief of Bureau.

(C) *Bureau summary*, consolidating the totals of the appropriation summaries; one copy for the accountant, one for the Chief of Bureau, and a third copy to be furnished the Secretary, if desired.

Each of these summaries will show the amount expended to date, liabilities or obligations for which funds are tied up, and the balance available for use.

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It will thus be seen that the essential features of the system of bookkeeping recommended by the committee for the Bureau of Plant Industry are:

(1) A file paper for every financial transaction.
(2) A single entry on an account card of name, date, and amount.
(3) An alphabetical index to both file papers and accounts.
(4) A simple but effective system of checking the accounts.
(5) A monthly financial statement, in detail and summarized, to be furnished every person in the Bureau interested, these statements and account summaries to be made at a single operation on the typewriter.

In our opinion the system outlined above will go far toward simplifying the work of the Bureau, effect a considerable saving in time and clerical labor, and place the whole matter of Bureau finances on a sound business basis. The plan does not necessitate the securing of additional help, but involves the shifting of certain assistants now carrying on the accounting work in the various offices in order to centralize the work under the direct charge of the Chief of Bureau.

Under this plan all business of a financial nature will be transacted by the central office, thus relieving the various offices and divisions of the Bureau of all such matters and enabling the clerical force of those offices to devote their undivided attention to other work; all papers relating in any way to authorizing or accounting for expenditures of the Bureau will pass through the new office, and in all matters relating to the accounts of this Bureau the Disbursing Officer will deal directly with the head of the central office.

During the year the Bureau has received and answered 240,000 letters on various subjects. Reference here is made only to letters which have asked for specific information and required, therefore, direct answers. The many thousands of requests received for publications, seeds, etc., are not included in the number here indicated. In connection with the regular work of the Bureau coming under this head may be mentioned the publications, of which there have been issued during the year 16 bulletins, 12 Yearbook papers, 11 Farmers' Bulletins, and 14 miscellaneous documents; a total of 53 publications, aggregating 2,274 printed pages, illustrated by 181 plates and maps, and 182 text figures.

CHANGES IN ORGANIZATION.

Owing to the nature of the work conducted by the Bureau of Plant Industry it is necessary from time to time to effect changes in organization. The shifting of problems and the changes that are required through work connected with new projects make it desirable to carefully examine each year, or more often if found to be advisable, the existing organization for the purpose of making improvement. The general policy of the Bureau is to make such examination at least once a year, and to bring about changes where changes seem to be desirable. During the past year a number of changes have been made with a view to a betterment of the service. The botanical work proper has been grouped under the general head of Systematic and Economic Botanical Investigations. Heretofore considerable of the systematic botanical work has been carried on in a number of branches of the Bureau, notably in the office of the Agrostologist, where sys-

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tematic studies of the grasses have been conducted for a number of years. All this work has been brought together and placed under the direction of the Botanist, Mr. F. V. Coville. The systematic grass collections have also been placed in charge of Mr. Coville. Mr. A. S. Hitchcock, who is in general charge of the systematic grass work, has been assigned to the office of the Botanist for a continuation there of his former work. With a view to an improved administration of the work, the Drug and Poisonous Plant Investigations have been placed under the direct charge of Dr. Rodney H. True, who reports to the Chief of Bureau. The Seed Laboratory, in charge of Mr. Edgar Brown, also reports directly to the Chief of the Bureau. With a view to bring about a closer coordination of allied investigations, the grain-grade investigations, formerly conducted by Mr. Carl S. Scofield, have been placed in charge of Mr. Edgar Brown, reporting directly to the Chief of Bureau. Investigations in Tropical Agriculture have been changed so as to include problems of more direct relation to agriculture in the United States. Mr. O. F. Cook has been placed in charge of this work and reports directly to the Chief of Bureau. His work has been broadened to include primarily investigations in the agricultural economy of tropical and subtropical plants.

In the last two or three annual reports special attention has been called to the work on Farm Management. Owing to lack of proper funds and organization, this work has not been pushed as rapidly as was desired. Under recent changes in organization, however, it has been made practicable to reassign a number of the investigations conducted in the office of the Agrostologist, and through this reassignment and readjustment the office of Farm Management has been organized under the direct charge of Mr. W. J. Spillman, the Agriculturist, assisted by men who have for some time been engaged in the grass and forage plant investigations. The propaganda work on grass and forage plants proper has been placed under the general supervision of Mr. A. J. Pieters, with Mr. C. V. Piper directly in charge, assisted by Mr. J. M. Westgate. Mr. Piper will give special attention to economic studies of forage plants, with particular reference to their introduction into all parts of the country. Close cooperation is being conducted with experiment stations in all this work.

Great interest has been manifested recently in the development of agricultural work in the West, especially in connection with the reclamation projects in charge of the United States Geological Survey. The Geological Survey has indicated a desire to secure the cooperation of this Department in connection with its work, mainly along the line of general farm demonstrations. It is recognized by the Reclamation Service that to make their work of practical value it must be demonstrated to the farmers what kinds of crops and systems of agriculture should be followed in connection with the various projects they have under way. By direction of the Secretary, this western agricultural work, which is as yet in a tentative state, has been placed in charge of Mr. Carl S. Scofield.

For the better administration of the Arlington Farm the work has been placed in charge of a committee, of which Prof. L. C. Corbett is chairman, the other members being Mr. A. J. Pieters and Mr. W. W. Tracy, sr. All matters pertaining to the work of the farm are handled by this committee.

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The details of the various lines of work conducted by the several organizations referred to here will be found elsewhere in this report.

CHANGES IN PERSONNEL.

From the 1st of September, 1904, to the 1st of September, 1905, the following changes have been made in the personnel of the Bureau:

Resignations	28
Deaths	4
Dismissals	3
Transfers	39
Furloughs and terminations of appointments	214
Total	336

During the same period there have been made 354 appointments, increasing the total force of the Bureau by 18. On September 1, 1905, the numerical force of the Bureau was as follows:

At Washington	307
Outside of Washington	201
Total	508
Total, September 1, 1904	490

At the last session of Congress numerous changes were made in the rolls of this and other Bureaus of the Department. All employees other than those engaged in scientific work were transferred from lump funds to the statutory rolls. These transfers took effect July 1, 1905. The number so transferred from lump-sum appropriations to statutory rolls under the act in question was 127. Eight positions were transferred from statutory rolls to lump-sum appropriations, making an increase in the number of statutory places of 119. These are not actual increases in the number of employees, but simply increases in places due to the creation of statutory places by act of Congress transferring them from lump-sum appropriations to statutory positions.

WORK IN COOPERATION WITH THE EXPERIMENT STATIONS.

The Bureau of Plant Industry is engaged in many lines of cooperative work with experiment stations. This work practically covers the whole range of the Bureau's operations, and the problems are continued from year to year as the necessities of the cases involved may require. At the present time the Bureau is engaged in active work with more than 40 stations. Special references to a number of these lines of cooperative relationships are made in the accompanying pages of this report.

During the year special attention has been given to bringing about a better and closer cooperation in our work in the South, especially with relation to the investigations having for their object the discovery of methods of meeting the ravages of the cotton boll weevil. A series of demonstration farms has been established, all this work being done in close cooperation with the stations. Close relationship with stations in the matter of conducting investigations of tobacco has also been effected, especially in New England. In connection with the forage crop propaganda work arrangements are being made with stations for carrying on a number of these problems, the general plan

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being for the Department to furnish the seed for demonstration purposes, and where it is necessary to follow up by careful studies within the States the seed distributed, funds are provided for an assistant to be located at the station to carry on the work. With a view to bringing about closer relationships in the matter of publications, arrangements have been made with a number of stations for the publication of station bulletins on matters of direct local interest. Thus, in connection with the tobacco investigations which have been conducted the past season in Connecticut, the results have been published as bulletins from the Connecticut Station. Also, in connection with the general propaganda and demonstration work with alfalfa, arrangements are being made for the publication of bulletins on this subject by the stations. The Department is primarily concerned with the consideration of such questions from the standpoint of the entire country, believing that so far as local matters are concerned they had best be looked after by the stations proper. The Bureau's policy is to furnish aid to the station in the matters of seed and assistance wherever it is practicable to do so.

SCHOOL-GARDEN WORK.

As set forth in my previous reports, the school-garden work, especially that part relating to the handling, cultivation, and propagation of plants, has attracted general attention. Prof. L. C. Corbett has been active in rendering assistance in this work in the preparation of circulars and bulletins dealing with practices to be followed in school gardens and in the distribution of seeds, plants, etc., for the work. During the year requests for information and assistance have been received from every State and Territory in the Union save three, and in addition to the work in this country, requests have come from Porto Rico. The States of New York, Ohio, and New Jersey have shown the greatest activity in school-garden work. Some 4,000 combinations of flowers, 3,000 of vegetables, and 500 ornamental collections, comprising a total of nearly 40,000 packets of seeds, were sent to New York alone, the other two States mentioned receiving about one-half this amount each. For individual school gardens there have been sent out over 15,000 collections of flower seeds, comprising 75,000 packets of five annual flowering plants, and nearly 14,000 collections, or 70,000 packets, of five sorts of vegetable seeds. A third collection of seeds, consisting of ornamental flowering plants suitable for school-ground decoration, comprising 30,000 packets, has been sent out. This makes a total of 175,000 packets of seeds supplied to schools during the year.

The work on the Department grounds in cooperation with the normal schools of Washington has been continued. This work is in charge of Miss Susan B. Sipe, of Normal School No. 1, and Miss Sara W. Brown, of Normal School No. 2 (colored). Great interest has been shown by the students. The work on the grounds consists of instruction given the normal school students in the matter of handling soils, propagating plants, handling seeds, etc. Under the direction of Miss Sipe the various school grounds of the city of Washington have been planted in accordance with plans prepared by the students. School-garden methods are also followed in the homes of the students and elsewhere, if opportunity offers. With the view of

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putting into practical operation the knowledge gained, a small area of land is set aside on the Department grounds for the use of the lower grade pupils. The direction of these pupils gives practice to the normal students, who will eventually become teachers in the public schools of the city. Plans have been made for the enlargement of this work, giving an opportunity for more extensive practice by the scholars in the minor grades, especially in the direction of planting the ordinary agricultural crops and correlating this work with the class-room studies. It is planned to give the school children opportunities to familiarize themselves not only with the methods of growing common farm and garden crops, but also to secure knowledge as to the importance and value of those crops to the country. Plat plantings are to be made, the plats themselves representing specifically the areas in acres devoted to common agricultural crops. The children will secure this information from reports and publications which are available, and will utilize it in connection with their plantings. The calculation of the amount of land to be devoted to certain crops will be correlated with work in arithmetic; studies in geography and other similar lines will also be correlated with the garden plantings. In addition, common systems of crop rotation, as practiced in various parts of the country, will be illustrated and practiced.

PORTLAND EXPOSITION.

Owing to the fact that a considerable part of the exhibit used at the St. Louis Exposition was available for the Portland work, no great amount of time was required to prepare the material selected for the purpose in question. A very creditable exhibit has been made, however, including several new features applicable to the Pacific coast. Particular attention was given to exhibits pertaining to grass and forage-plant work, cereal work, work on fruits, new introductions, etc.

SPECIAL WORK ON COTTON.

The special work on cotton outlined in my last report was continued during the year. Carrying out your recommendations, there was appropriated by Congress the sum of $190,000 "to enable the Secretary of Agriculture to meet the emergency caused by the ravages of the Mexican cotton boll weevil and other insects and diseases affecting cotton; to study diversification of crops and improvement of cotton by breeding and selection in the Southern States." Under your direction this fund was, as heretofore, handled jointly by the Bureau of Entomology and the Bureau of Plant Industry, $105,500 being devoted to the work of the latter Bureau. The lines along which the investigations were conducted may be briefly reviewed as follows:

FARMERS' COOPERATIVE DEMONSTRATION WORK.—The first year's experience with this demonstration work, which is under the direction of Dr. S. A. Knapp, showed that it is exceedingly popular throughout Texas and Louisiana; and the main plan, as set forth in my last report, was continued, with some changes made necessary by the experience gained during the former season. Briefly, the work has for its object the bringing home to the farmer of the most

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practical methods of growing cotton despite the presence of the weevil, the utilization of early maturing varieties, the use of fertilizers and proper methods of cultivation and tillage, the burning of stalks, and, in short, a thorough system of crop management, with the main idea of securing and making a crop, through the planting of early varieties, before the weevil has had opportunity to develop sufficiently to completely destroy the squares or bolls. The work, in the main, has been conducted through special agents, who have been assigned certain territory. These agents visited representative farmers, secured their cooperation in the matter of making demonstrations, and then outlined a general plan of farming operations along the lines already pointed out. As stated in my last report, about 5,000 farmers in Texas were engaged in this work, and fully that many this year have also been cooperating with the Bureau, the majority being located in the boll-weevil districts of Texas and Louisiana.

PLANT-BREEDING WORK.—The work on plant breeding, under the direction of Dr. H. J. Webber, so far as it relates to securing types of cotton better adapted to the climatic and soil conditions existing in the boll-weevil-infested district, was continued during the year. As the result of the breeding work last season several varieties of considerable promise were secured. The headquarters for the experiments were moved to Waco, where a laboratory has been equipped for the use of the investigators engaged. A large portion of the work, particularly that relating to earliness and resistance to the weevil, was carried on during the season on farms in the vicinity of Waco. Necessarily work of this character must be conducted in the boll-weevil section. These matters are more fully discussed under plant-breeding work proper.

COOPERATION WITH STATE EXPERIMENT STATIONS.—Cooperation in connection with this work has been carried on with the Texas Agricultural Experiment Station and the Louisiana State Experiment Station. The Texas Agricultural College and Experiment Station have been making special efforts in the matter of encouraging seed selection throughout the State. Extensive work has also been carried on in the fertilization of cotton with a view to securing earliness. Cooperation by the Bureau in the farmer's institute work has also been continued with the Texas station, the plan being to aid the college authorities in the general propaganda work throughout the State.

DIVERSIFICATION FARMS.—The organization of diversification and demonstration farms, as set forth in my last report, was continued during the year. This work is in charge of Prof. W. J. Spillman, who is cooperating with the experiment stations in the different States where these farms are being developed. Definite systems of farm management are being worked out by Professor Spillman, in consultation with the station authorities and the best farmers in the respective regions where the farms are located. Some of these farms are proving quite successful, and serve as a means of bringing about changes in agricultural practices that could not be secured in any other way. It is not the object of this work to establish model farms, but to organize the work in such a way that the farms will be placed as soon as practicable on a thorough and sound business basis. The

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main idea running through the work is to encourage diversified agriculture and point out that by diversification farming can be made more remunerative than where the one-crop system is followed, and that at the same time the land can be improved.

COTTON DISEASES.—Work on cotton diseases, under special authority, was continued by Mr. C. L. Shear, attention being given chiefly to root-rot. Various lines of investigation were carried on with a view to determining the effect of cultural processes, rotations, etc., on the control of this disease. The main portion of this work was done in Texas and partly in cooperation with the agricultural college. Other diseases of cotton, such as wilt, have received some attention, the work being conducted mainly in Alabama, Georgia, and to some extent in Mississippi.

INTRODUCTION OF NEW COTTONS AND THE STUDY OF TROPICAL COTTONS AND OTHER CROPS IN THEIR RELATION TO BREEDING WORK IN THE SOUTHERN STATES.—This work has been in charge of Mr. O. F. Cook, who has obtained some very valuable information in reference to the existence of entirely new types of cotton in Central America and in South America. Quick-maturing long-staple cottons have been discovered and it is deemed highly important that the life history of these cottons be fully worked out with a view not only of introducing them into the Southern States, but of using them as a basis for further breeding work. Several parties were sent to Central America the past season, where further collections of seeds of cottons and other crops suitable for the Southern States have been secured and, in part, planted in the South.

REPORTS OF EXECUTIVE OFFICERS.

In the accompanying reports are given summarized statements of the principal officers of the Bureau.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

The pathological and physiological work of the Bureau, directed by Mr. Albert F. Woods, is divided among ten principal laboratories and special lines of investigation. The work in progress in these laboratories is briefly reviewed under the following heads:

PATHOLOGICAL LABORATORY.

The work of this laboratory, conducted under the immediate direction of Dr. Erwin F. Smith, has continued along the same lines as in former years. During the year specimens and requests for information as to causes and remedies for plant diseases have been received from a great many persons, including residents in nearly every State and Territory within the United States, and from various places outside, e. g., Hawaii, the West Indies, etc. The identification of these diseases and suggestions as to remedies when any were known have consumed a very considerable part of the time of the laboratory force. In addition to this the regular routine work of the laboratory, which includes the study of the life history of various plant parasites, has been carried on.

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Work has been continued on the olive-tubercle organism, and a number of additions have been made to the knowledge of its life history. Studies on Burrill's bacterial disease of broom corn have been continued, the life history of the parasite has been worked out as far as possible, and numerous pure-culture inoculations have been secured. There are indications that the disease may be overcome by selection of the most resistant varieties. Work has been continued on sugar-cane diseases and on cotton diseases. Considerable work has also been done on the bacterial spot disease of beans, and a resistant variety has been discovered. Some additional work has been done on the life history of the organism isolated from the cocoanut bud rot of the West Indies. Studies have been continued on the wilt disease of cucurbits and on the bacterial disease of the tomato and potato.

During the last half of the year the laboratory force was considerably reduced by transfer and resignation. This allowed sufficient funds to pay for the European explorations of Prof. L. R. Jones on diseases of the potato, described elsewhere in this report.

SUGAR-BEET WORK.

The sugar-beet investigations, conducted by Dr. C. O. Townsend, have progressed along the same lines as were outlined in previous reports. Some of the more important features of this work are described as follows:

DISEASES OF THE SUGAR BEET.—As in the previous years, two diseases were specially serious last season, namely, the curly-top, or western blight, and the leaf-spot, or eastern blight. In regard to the former disease, efforts have been made to determine the cause of the malady and to find methods for combating it. Thus far it has been impossible to find any specific organism to which the cause of this disease can be attributed. It seems to be due to a combination of unfavorable conditions of soil and climate, although our investigators have not been able to find just the combination of conditions that will produce the disease artificially.

The cause of the leaf-spot, or eastern blight, is well known, being produced by the fungus *Cercospora beticola*. We have demonstrated that this disease may be completely controlled by spraying with Bordeaux mixture. Several points need further investigation before a complete report can be published in connection with this disease.

SINGLE-GERM BEET SEED.—During the past winter a report on the progress of this work was published by the Department (Bulletin No. 73 of the Bureau of Plant Industry). This report shows that by selection the percentage of single-germ seeds has been increased from less than two to more than twenty-five. The crop of single-germ seed produced last season has been planted and promises a good supply of seed beets for next season's operations. The indications are that a single-germ seed adapted to the production of sugar beets on a commercial scale will be produced in sufficient quantity for field demonstrations within the next few years.

FERTILIZERS FOR SUGAR BEETS.—For several years efforts have been made to increase the yield of beets by the application of various forms of fertilizers without in any way impairing the quality of the product.

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During the past season green manures, stable manure, and commercial fertilizers have been used. The effect of these various forms of fertilizers is set forth in a chapter in the Report on the Progress of the Beet-Sugar Industry in the United States for 1904.

IMPROVEMENTS IN YIELD AND SUGAR CONTENT THROUGH SELECTION.—During the past year selections have been made from several fields of beets with a view to obtaining a larger beet which should contain a high percentage of sugar and a satisfactory purity coefficient. It is confidently expected that the continuation of the work along this line will result in a greatly increased yield per acre without any reduction in sugar content. Selections have also been made with a view to producing a strain of beets that will mature earlier than the ordinary crop. This will lengthen the harvesting season and enable the factories to handle a larger quantity of beets. Selections have also been made with a view to obtaining beets resistant to alkali. This selection work has been inaugurated in conjunction with Mr. Thomas H. Kearney, of the Plant-Breeding Laboratory, and is referred to later in this report.

SILOING SUGAR BEETS.—During the winter of 1903–4 many of the seed beets which were siloed for seed production in 1904 decayed during the winter, resulting in a large financial loss to those who were interested in the production of sugar-beet seed on a commercial scale. Efforts were made in the autumn of 1904 to find some satisfactory method for siloing the beets for the purpose indicated. Accordingly silos of various forms were used in putting away the beets for winter, and a careful examination of the siloed beets was made in the spring of 1905. On the whole, the beets kept much better in all cases during the winter of 1904–5 than they did during the winter of 1903–4, but the poorest results were obtained where the shed silo was used. The beets kept best when they were simply piled up on the ground in a place where there was good drainage and where they were covered with sufficient soil to prevent freezing.

DISEASES OF ORCHARD FRUITS.

The work on the diseases of orchard fruits, as in past years, is under the immediate direction of Mr. M. B. Waite, who has the assistance of Messrs. W. M. Scott and P. J. O'Gara. Without attempting to mention all the minor investigations and details of studies in the field and examinations of material sent to the laboratory, the following are the principal subjects that have been investigated during the year:

PEAR-BLIGHT.—Considerable attention has been devoted to pear-blight. In Georgia the work has been entirely of a demonstration character, and the extensive experiments carried on by Mr. P. J. O'Gara at Cairo, in the orchard of Mr. J. B. Wight, and at Calhoun, in the orchard of Mr. Hillhouse, were continued for the third season. The eradication of blight has been nearly complete in these orchards. The experiments, while not absolutely perfect, were as successful as could be expected.

Field investigations on this disease were undertaken in Colorado and in California, two extensive trips being made for that purpose. In California a demonstration experiment has been started in coopera-

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tion with the California Experiment Station. Two commercial orchards were selected, and two assistants under Prof. Ralph E. Smith's immediate direction carried on the work. In one of the orchards the success was almost, if not quite, complete; in the other orchard, which was in close proximity to badly infested orchards, the work was only fairly successful. It is proposed to continue and extend this work in California in cooperation with the State experiment station and the State horticultural and county horticultural commissions. The endeavor will be to eradicate the blight over large areas, instead of confining the work to single orchards.

"LITTLE PEACH."—"Little peach" has been investigated in Michigan and New York, and experiments in budding and inoculation are under way in the experimental orchard on the Potomac Flats. The main work of the season, however, is a large demonstration experiment in Saugatuck Township, Michigan. This was the second year of this three-year test in eradication of "little peach" over a large district, covering about 7 square miles of territory rather thickly planted to peaches. As a result of the painstaking eradication work in the summer of 1903, in carefully going over the orchards in 1904 only about one-tenth as many diseased trees were found. Where, in round numbers, about 4,000 infected trees were taken out the first year of our inspection, as the result of this eradication only about 400 diseased trees could be found in 1904. Nearly 100 of these trees were found in a single young orchard just coming into bearing, and this lot occurred under conditions which led us to believe that the disease had been budded into the trees when they were propagated as nursery stock. The experiment is to be continued the coming year, and if the results are in the same proportion as those of the past two years the experiment will be concluded to the entire satisfaction of all parties concerned.

The Michigan State inspector of nurseries and orchards is cooperating in this work through the appointment of Mr. Horace Welch as deputy State inspector for this special duty.

WINTER INJURY.—The investigation of winter injury of fruit trees, begun in March, 1904, was continued to a considerable extent during the past year. Further studies were made in western New York and in Michigan, and a new and peculiar type of injury was found, which we call "collar girdle." This probably has occurred before; in fact, we knew of the injury on apple trees, but never in our experience during the last sixteen years has there been as much and as widespread destruction of peaches in the Northern States by this type of disease.

BROWN-ROT OF PEACHES AND STONE FRUITS.—The subject of brown-rot is assigned to Mr. W. M. Scott. He has carried on an elaborate series of experiments in the field and in the laboratory. Many interesting details about the life history of the brown-rot fungus have been worked out by Mr. Scott during the past year and a series of drawings prepared, microscopical and otherwise, illustrating the principal features of the disease. The field work is being carried on in the large orchard of J. H. Hale, at Fort Valley, Ga. Last season, [illegible]nt of the unusually dry weather, this series of field tests, [illegible] complicated to describe here, was rendered practically

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worthless, for the reason that so little rot appeared in the orchard. This season Mr. Scott persistently repeated practically all of this experiment, with some modifications, and on account of a normally rainy season there was an abundance of rot. The results to date indicate that Bordeaux-mixture spraying and other remedial measures in such a season show their value in reducing the rot, but do not entirely prevent it.

BITTER-ROT OF APPLES.—A carefully conducted series of experiments in spraying and dusting against the bitter-rot of apples is being carried on by Mr. Scott at Afton, Va. After starting these experiments the previous season they were stopped on account of the failure of the trees to set fruit. This year there is a fine crop of fruit, and results of value are looked for. In carrying on this work a subsidiary experiment has been planned by Mr. Scott for the purpose of demonstrating to Virginia orchardists the value of early spraying against apple scab on the Winesap and some other susceptible varieties. Mr. Scott is also making a careful test of dust spraying, so called, in comparison with the liquid sprays.

In Missouri Mr. F. W. Faurot, in cooperation with the Missouri Fruit Experiment Station, is carrying on a similar set of experiments, both spraying and dusting, against the bitter-rot and other apple diseases of that State.

A NEW APPLE CANKER.—Mr. P. J. O'Gara is investigating a new apple canker, which forms spots on the twigs and branches and which girdles nursery trees. The fungus has been identified and much of its life history worked out. Mr. O'Gara reports that it also occurs on roses as a serious disease and attacks some other rosaceous plants.

BLACK-HEART OF APPLE TREES.—The serious trouble in our West Central States known as black-heart is under investigation by Mr. O'Gara. He has made some interesting studies in regard to the nature of this disease and is investigating its life history. During the past year the results of a Hungarian investigator have been published, and to our surprise many of the facts worked out by Mr. O'Gara were discovered independently and published by the Hungarian scientist. This does not in any way detract from the importance of these discoveries, and the investigations should be further pursued until some satisfactory remedy can be found. The cause of the disease is well known. Its life history, however, has not yet been completely worked out.

ROOT-ROT OF FRUIT TREES.—Great damage has occurred in several parts of the country, notably in the peach orchards of Georgia and adjacent States and in the orchards of California, due to root-rot fungi killing the trees. These diseases (for there are probably several) attack the trees underground and are difficult to investigate. They probably will be extremely difficult, if not impossible, to treat. As this is one of the difficult problems of plant pathology it should receive all the more careful investigation by this Department. We have made some studies and inoculations on these diseases and hope to do further work during the coming season. This is not, however, a very promising line for securing successful results in the way of remedies.

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DISEASE-RESISTANT MELONS AND COWPEAS.

DISEASE-RESISTANT WATERMELONS.—In continuation of previous work, the third generation of melons developed by Mr. W. A. Orton from a hybrid between the naturally wilt-resistant citron and the watermelon was grown in isolated plats on infected land at Monetta, S. C. The results were promising. The uniform excellence of one strain in particular has convinced us that a melon of good quality can be secured from this cross, and the success of future work will depend entirely on our ability to maintain by selection the present standard of wilt resistance shown by these hybrids. The cooperative breeding work with the North Carolina Experiment Station has been continued, and satisfactory progress has been made. A large number of new crosses were obtained, which include several wilt-resistant melons of good quality. These experiments will require a term of years to complete.

COWPEA EXPERIMENTS.—Mr. Orton has continued the breeding experiments designed to produce varieties of cowpeas resistant to wilt and root-knot, and thus adapted for rotations with cotton on infected land. The Iron cowpea has been widely successful in the hands of farmers, as in previous years, and many of the new hybrids are more productive and equally resistant to disease. These were tested more thoroughly the past season and additional selections made. New crosses have also been obtained.

DISEASES OF MISCELLANEOUS CROPS.

PECAN DISEASES.—The nature and distribution of the more important pecan diseases have been studied by Mr. Orton. His experiments indicate that thorough spraying will control the scab of the leaves and nuts. Rosette, a more serious disease, has not been successfully treated, and it threatens to become a serious problem in the South. Several minor diseases have been studied, with the expectation of preparing a complete account of them all during the next year.

DISEASES OF TRUCK CROPS.—The demonstration experiment conducted last year by Mr. Orton to control the downy mildew of the cucumber, at Charleston, S. C., yielded results this season. Last year the disease did not appear in time to be much affected by the spraying. This year a severe epidemic began very early and destroyed all fields that were unsprayed or not thoroughly sprayed, while on 40 acres sprayed in accordance with the Department's directions a reasonable crop was secured. An account of this work for publication is nearly completed.

PLANT-DISEASE SURVEY.—The usual Yearbook article on the prevalence of plant diseases was prepared from reports obtained by correspondence with experiment stations and from the records of this office. The work, which is in the immediate charge of Mr. Orton, has been considerably extended by arranging a special plant-disease survey in cooperation with a number of the State experiment stations.

DISEASE RESISTANCE IN POTATOES.—A large collection of European varieties of potatoes was obtained by Prof. L. R. Jones, after a thor-

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ough study of conditions abroad. These are reputed to be disease resistant, and a cooperative trial has been arranged with the Vermont, Colorado, Oregon, and Florida experiment stations and at the Arlington Farm. The crop has already been harvested in Florida, and the results gave much promise of future success, as great variations in resistance were noted. Further trials will be needed to show what value these European varieties have for this country. A bulletin on this subject has been prepared for publication by Professor Jones.

CRANBERRY DISEASES.—The field work on cranberry diseases has been continued by Mr. C. L. Shear. Our efforts have been devoted chiefly to testing remedial measures, especially the application of fungicides. Very gratifying success has been obtained, and a Farmers' Bulletin has been published giving an account of the work and its results and of the methods employed. Laboratory studies of the fungi producing the cranberry diseases have been continued and further knowledge of their life histories has been obtained, which will be of value in perfecting our methods of combating these diseases.

RICE DISEASES.—For a number of years the rice industry of South Carolina has suffered from a disease popularly known in that State as "blast." In some localities this disease has practically destroyed the industry. At the earnest request of growers this Department last year undertook a preliminary investigation of the trouble, in cooperation with the State agricultural experiment station. Prof. Haven Metcalf, botanist of the station, made a careful survey of the rice fields of the State and inaugurated a number of experiments to determine, if possible, the cause of the trouble and some method of controlling it. He found a fungus always associated with the disease, but the susceptibility to attack seemed to be influenced by certain soil conditions which must be thoroughly investigated. The decline in the industry was found to be due not alone to the injury from disease, but to numerous other factors, and it seemed necessary to undertake a thorough investigation of the whole situation. This has been provided for in the appropriation for the current fiscal year and the work is now in progress.

NEMATODE WORK.

Owing to the great loss caused each year through the agency of nematodes, it was deemed desirable to make a thorough investigation of the diseases caused by these parasites. The work has been assigned to Dr. E. A. Bessey. Because of the lateness of the season when the work was begun (the end of October) the winter was mainly occupied in a thorough search of the literature of nematode diseases, a card index of titles, as well as host and parasite indexes, having been made. A study was begun, accompanied by greenhouse cultures of nematodes affecting the heads of grasses. An experimental plat at Monetta, S. C., was planted with nearly 400 species of plants, mostly cultivated varieties, for the purpose of determining as far as possible in a preliminary way what plants are susceptible to the attack of the root-knot nematode (*Heterodera radicicola*),

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BLUING OF WOOD.

Experiments were made in the laboratory with a great many different chemicals to determine what substances would prevent the development of *Ceratostomella*, the fungus that causes the bluing of wood. Upon the completion of these preliminary tests, Doctor Bessey, who has been assigned to this work, proceeded to Marianna, Ark., and Grandin, Mo., where, under the direction of Dr. Hermann von Schrenk, he made dipping tests of large quantities of lumber, respectively sweet gum and shortleaf pine, to determine the value of the methods worked out in the laboratory. Although these tests have not been concluded, the results seem to indicate that almost complete success will eventually be attained.

WORK ON PLANT BREEDING.

The work on plant breeding, conducted by the staff of the Laboratory of Plant Breeding, under the immediate direction of Dr. H. J. Webber, has been very successful, and in several important lines of investigation has produced new sorts of great value. New varieties of hardy oranges, new pineapples, new tobaccos, and new races of corn and cotton have been developed in the course of the experiments. In several instances these have been distributed to growers, and in other cases they are being propagated for distribution. Following is an outline of the main lines of investigation:

COTTON BREEDING.

PRODUCTION OF LONG-STAPLE RACES.—The cotton varieties grown in the extensive cotton area of the United States are almost wholly short-staple types, producing fiber from seven-eighths of an inch to 1 inch in length. A few long-staple Upland varieties exist which bear fiber from 1¼ to 1⅜ inches in length and which are of finer and better quality than the short staple. These long-staple sorts are, however, late in season, hard to pick, unproductive, and have a weak staple. Careful breeding experiments have been made with the object of securing improved new varieties not possessing these detrimental characters. Some promising new varieties have been bred which produce 1¼-inch-long lint, while others have been bred to produce fiber averaging respectively 1⅜ and 1½ inches. These have large bolls, somewhat like Upland cotton bolls, which open well and are easy to pick. The preliminary trials of these varieties indicate that they will be productive and yield very valuable lint.

PRODUCTION OF PEDIGREE STRAINS OF SHORT STAPLES.—It is of the highest importance that more productive strains of our ordinary varieties be produced, and in order to demonstrate what can be accomplished in this direction, it may be stated that several standard varieties have been subjected to careful grade breeding in order to secure more highly productive strains. One of these varieties has shown marked improvement, and it is planned to distribute seed to growers at the end of this season should it hold up in productiveness this year as in previous years. The short-staple varieties cultivated the country over could doubtless be easily improved so that they

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would produce fiber averaging $1\frac{1}{16}$ to $1\frac{1}{8}$ inches in length instead of the present average of seven-eighths of an inch to 1 inch in length. Several varieties are being carefully selected with this end in view and give promise of resulting in new strains of great value.

EGYPTIAN COTTON.—The experiments in the introduction and establishment of Egyptian cottons, begun in 1900, are being vigorously pushed, with some slight changes for the better from the plans of last year. As stated in the report of 1904, manufacturing tests of American-grown fiber have conclusively shown that we can produce in the United States Egyptian cotton fiber fully equal in length, strength, and quality to the imported staple. It still remains to be shown, however, where these cottons can be successfully grown. In several favorable seasons in South Carolina, yields nearly equivalent to the best crops of Upland were obtained and served to encourage the hope of ultimate success. Five seasons of experimentation at different places in South Carolina, however, have proved a disappointment in yield and have led to the conclusion that a more southerly location, where a longer season can be secured, will be more favorable. The experiments have been transferred this year to southern Georgia, where the growing season is normally from two to three weeks longer than in South Carolina. Some of the white-fibered varieties have already given very promising results in this section, and it is hoped that profitable crops of the selected strains can be grown.

Experiments have been continued in Arizona and New Mexico, and the selected strains in New Mexico last year gave a good crop, encouraging the belief that new varieties can be rendered well adapted for general culture in that section.

NEW CITRUS FRUITS.

As a result of the breeding experiments with oranges and other citrus fruits many valuable new sorts have been produced. Two hardy hybrid oranges that can be grown successfully from 300 to 400 miles north of the present orange regions of Florida were last spring distributed to nurserymen and growers in ten States and two Territories. Being distinct from any existing class of citrus fruits, these hardy types have been called citranges, and the two varieties distributed were named the "Rusk" and "Willits" in commemoration of the services of the first Secretary and Assistant Secretary of the Department of Agriculture. A third hardy orange, or citrange, has been developed since the last report was submitted, which produces a fruit as large as an ordinary orange and of much better quality than the Rusk or Willits citrange. If it proves productive it will be of great value.

Two new kid-glove tangelos have been produced by crossing the pomelo with the tangerine orange, which give promise of being valuable market fruits. They are very tender and can be grown in Florida and California only. Several improved varieties of tangerines and ordinary oranges, early in season and of superior quality, have also been produced which will be good for general cultivation in orange-growing districts. Five of the new types have been described and illustrated in an article in the Yearbook for 1904.

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NEW PINEAPPLE VARIETIES.

The pineapple breeding work was started several years ago and is now nearing completion. Many new varieties have been produced which will certainly prove of value for cultivation in Florida, Porto Rico, Hawaii, and the Philippines. At present only one smooth-leaved variety is grown and this is far from satisfactory for all conditions. The coarse spines on the leaves of the other varieties render them hard to handle and the quality in the most generally cultivated and best shipping sorts is very inferior. Many new smooth-leaved sorts have been produced which are of different seasons of ripening and of different flavors, shapes, sizes, etc., so that they will fill many conditions.

CORN BREEDING.

SELECTION EXPERIMENTS.—During the past year the corn-selection work, carried on by Mr. C. P. Hartley, ahs been continued with eight strains of corn which the Department is improving and adapting to the soil and climatic conditions of different sections of the country. The crops harvested the past season from these various strains showed considerable improvement in regard to uniformity and production. A large-eared white variety has been much improved and adapted to bottom soils of the Central States, and two other strains, one a yellow dent and the other a white dent corn, have been improved and adapted to upland conditions of the same section of country. These strains have already shown their superiority in comparison with other varieties of corn. Selection work has been continued in central Texas upon a large-eared white dent corn that produces one ear to the stalk, and also upon a white, prolific corn that produces two or more ears per stalk. While the past year's work with these strains was but the second year of the selection, they exhibited much improvement in uniformity and production and are already much superior to the strains of corn commonly grown in Texas. The breeding work of the past year upon white dent corn suited to fertile soils in the Eastern States was very satisfactory, the yield of the breeding plats being in excess of 100 bushels per acre.

In addition to the production of improved strains of corn in the various sections where this work is carried on, a very great benefit results from the object lesson it offers in the community where the work is performed. To several hundred farmers suitably situated a number of select seed ears of improved strains have been distributed, the farmers agreeing to give them a test in comparison with the most productive strains they have previously grown and to render the Department an exact account of the relative merits of the corns. By this means it is hoped to determine the sections of country to which the various strains are adapted, and their production in comparison with many ordinary corns that are customarily grown in those sections.

NEW STRAINS PRODUCED.—Selection work has continued with four hybrid corns produced by the Department several years ago, which are now quite promising. Some of these are being bred for upland conditions and others for bottom lands, and one is a corn especially suited to the making of hominy. These hybrids combine in a very

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satisfactory manner the good qualities of the parent strains and are this year being tested for production in comparison with the most productive varieties now in existence.

VARIETY TEST WORK.—The variety test work begun in 1903 with the best existing varieties, in cooperation with the experiment stations of the Central and Southern States, is being continued, and in the spring of 1905 similar work was begun with 14 of the best and earliest varieties of corn in existence in cooperation with the experiment stations of the Northern States. For this work seed is obtained by the Department each year from the same localities, and uniform lots are distributed to the various stations cooperating. The object of the work is to show which of the best existing varieties are most productive in the various States, and to throw light upon the effects produced by growing seed in one locality and planting it in another.

COMPARISON OF POLLEN FROM SUCKERS AND MAIN STALKS.—During the past year an experiment was conducted to determine whether pollen produced by a sucker is as effective in producing good seed as pollen from the main stalk upon which the sucker grows. This experiment was conducted with 60 hand-pollinated ears of a variety of corn that produced three or more ears per stalk. In order to get reliable results it was found necessary to ascertain any superiority that may exist in upper or lower seed ears of the same stalk. To secure this the pollen from a sucker was in many cases placed upon the upper ear and the pollen from the main stalk upon a lower ear, while in other instances the reverse method was employed. The result of the experiment shows that the pollen from the main stalk is in no way superior to the pollen from a sucker or suckers of that same stalk.

IMPROVEMENT OF SWEET CORN.—In Virginia and Texas breeding work has begun, having as its object the production of sweeter, tenderer, and more productive strains of corn for table use. In the prosecution of this work the best plant-breeding methods, including both hybridization and selection, are applied. In New York and Ohio breeding work is being conducted in cooperation with canneries, so as to produce hardier and more productive strains of corn adapted to canning purposes. While this work has just been started, it has already stimulated canners in producing their own seed corn, and has done much toward removing the long-established opinion that good sweet corn can be produced only in the New England States.

IMPROVING THE OAT CROP.

Breeding work with oats has been continued by Mr. J. B. Norton, and very promising results have been secured. Efforts have been largely directed toward securing more productive varieties for the rich farm lands of the Mississippi Valley region, where oats are grown extensively in rotation with corn. Ordinary varieties have run down to such an extent, especially in production and fertility or filling-out character, that their cultivation is unprofitable in many sections. Careful pedigree breeding experiments are being carried on with the varieties that have proved most satisfactory, and some

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of the new strains are giving exceptional results. Many hybrids have been made between promising varieties, and some of these exhibit in a marked degree the increased vigor which sometimes occurs as an effect of hybridization.

POTATO BREEDING.

The breeding of potatoes is being continued along the same lines as last year: (1) The production of new seedling varieties, and (2) the selection of tubers. New seedlings have been obtained in the course of the work which are very promising, but they require further testing and selection to determine their real merit. The time of the investigator in charge of the work has been so thoroughly occupied with the oat-breeding work that it has been impossible to push the experiments as rapidly as their importance demands.

ALKALI-RESISTANT CROPS.

WORK ON RESISTANT FIELD CROPS.—The work on resistant field crops is being carried on at several localities in the West and Southwest under the immediate supervision of Mr. T. H. Kearney. The object is to secure, by selecting seed from the most resistant plants, strains that will endure greater amounts of alkali in the soil than those commonly grown. The work is being continued with alfalfa, wheat, barley, and oats, both American and foreign varieties being used as the basis. Incidentally it has been found that some of the alfalfas and cereals imported from the Old World by the Office of Seed and Plant Introduction and Distribution are already more resistant to alkali than the native sorts commonly grown in the region where experiments are being carried on.

During the past season (1904), in cooperation with Dr. C. O. Townsend, pathologist in charge of Sugar-Beet Investigations, work was begun with sugar beets, and there is every indication that it will be practicable to develop a markedly resistant strain of this crop. During the present season (1905) the production of alkali-resistant strains of sorghum, which is generally considered one of the best crops for alkali lands, has been undertaken. In cooperation with Mr. W. T. Swingle, physiologist in charge of Plant Life History Investigations, a study of the alkali resistance of different varieties of the date palm has been commenced.

LABORATORY INVESTIGATIONS.—An important investigation recently completed was the determination of the comparative resistance to alkali salts of eight varieties of wheat from different parts of the world. As a result it has been clearly shown that some are more resistant than others, and that certain varieties, not always those that are highest in general resistance, will endure larger amounts of some particular salt than will other varieties. This is considered a valuable indication of the value of certain varieties for localities where the alkali consists mainly of some one salt. The results obtained are described in detail in Bulletin No. 79 of the Bureau of Plant Industry, recently issued. Similar work now being carried on with sorghum has so far brought out less difference in the resistance of different varieties than was the case with wheat.

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IMPROVING TOBACCO VARIETIES.

The experiments in tobacco, started in the summer of 1903 by Mr. A. D. Shamel, have yielded very gratifying results. Experiments are being conducted with three main classes of varieties: (1) Cigar wrappers and binders; (2) cigar fillers; (3) smoking and export tobaccos.

CONNECTICUT WRAPPER TOBACCOS.—In the Connecticut Valley experiments with the varieties of tobacco under shade have been directed toward the production of a uniform type of desirable quality and profitable yield. The experience of growers in this section has shown that it is impossible to grow profitable crops of shade tobacco with the varieties introduced for this purpose. In these experiments it has been found that by carefully saving seed from the best plants under bag uniform strains of the finest types of tobacco may be secured, and these strains are now being tested commercially in cooperation with the Bureau of Soils.

The production of new strains adapted for growing under cloth shade is another highly important line of experiment. The native Broadleaf and Havana seed varieties have been used for this purpose. By the selection and hybridization of these sorts with imported Cuban and Sumatra sorts valuable results have been secured. The growing of these new strains and hybrids is being taken up by the growers in a conservative way, with good results.

Encouraging experiments have also been made in the improvement of the native Havana seed and Broadleaf tobaccos by selection, and have resulted in the production of improved strains, producing larger yields of a better type and quality for cigar wrappers. These improved strains have been placed in the hands of growers and are being generally used in the Connecticut Valley. All these experiments are being conducted in cooperation with the Connecticut Agricultural Experiment Station.

WRAPPER AND FILLER TOBACCOS IN THE SOUTH.—In Florida and southern Georgia experiments similar to those in Connecticut were begun last year, with a view to improving the uniformity of the tobacco grown under slat and cloth shade. Many of the selections have shown great uniformity this year, and have won the favorable comment of all growers who have carefully examined them. Experiments have also been started in Florida in the improvement of filler tobaccos, but results have not yet been secured.

MARYLAND SMOKING TOBACCO.—The investigation of Maryland tobaccos, which are largely used for export trade and for the manufacture of smoking tobacco, shows that there is a great lack of uniformity of type in the varieties and that the yield of the desirable types is very low. Experiments have shown that the type has been greatly improved in uniformity, and it is believed that the yield will also be greatly increased. Hybrids of the native Maryland tobaccos with other varieties give great promise of producing improved varieties combining the hardiness and yield of the native sorts with the superior quality of certain imported sorts. These experiments are being carried on in cooperation with the Maryland Experiment Station.

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METHODS OF SAVING SEED.—Extensive experiments have been made with seed saved under bag, free from cross-fertilization, in comparison with seed saved in the ordinary way. It has been conclusively shown that seed saved in the first way produces plants of more vigorous growth and of greatly improved uniformity of type. Accordingly tobacco growers have largely adopted the method devised by saving seed under bag, which is at once simple, cheap, and profitable.

SEED SEPARATION.—It has been proved beyond a doubt in the course of these experiments that heavy seed produces better plants than light seed. Owing to the fact that tobacco seed is so extremely minute and that the difference in size and weight of the individual seed is so very slight, no thoroughly satisfactory means had been devised of making a separation of the light from the heavy seed. During these investigations a simple practical machine has been invented for the purpose, which makes an admirable separation of the light from the heavy seed.

DISEASE-RESISTANT VARIETIES.—The wilt disease of tobacco has been a source of great loss and is slowly but steadily spreading into the largest tobacco-growing sections. It is regarded as a formidable menace to the industry. A few plants apparently resistant to the disease were found in a badly infected field in the Connecticut Valley, and seed of these was selected for breeding. Last year the progeny grown from such plants proved resistant to the disease, thus demonstrating beyond a doubt that it is possible to develop resistant strains. In Florida and southern Georgia the root-knot disease, or nematode, is rapidly becoming the most dreaded enemy of the tobacco industry. Often the yield of a crop is reduced to one-half and in some instances the entire crop has been practically destroyed. By the selection and growing of resistant plants it has been discovered that this resistance to the disease is in some degree inherited, and consequently that resistant strains can probably be developed. This fact is of peculiar value in Florida, where the cost of erecting shade and growing a crop under it is very great, and the loss to the grower in case his crop is destroyed is correspondingly large.

STRAINS SECURED BY HYBRIDIZATION.—The Broadleaf and Havana varieties of tobacco, grown widely in the Connecticut Valley, are far from satisfactory. Only a small portion of the leaf near the tip can be used for cigar wrappers. The base of the leaf has coarse veins and lacks body and grain, which are necessary qualifications in a good wrapper leaf. By hybridizing these varieties with imported Cuban and Sumatra, new varieties have been obtained which have rounded leaves of uniform texture from tip to base, small, delicate veins, and an even grain, all of which make the entire leaf useful for cigar wrappers.

CEREAL INVESTIGATIONS.

The following are the main lines of grain investigations for the past year, conducted under the immediate supervision of Mr. M. A. Carleton:

WINTER-WHEAT EXTENSION.—The departmental experiments with winter wheat, in cooperation with the State experiment stations

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and with various farmers, have been increased in number and have been followed in almost all cases with success when the hardiest varieties were used, even as far north as the southern portions of North Dakota and Minnesota. At the same time the proportional area given to winter wheat in the Northwest appears to have increased considerably, though accurate statistics are not yet possible. Much has been learned and in turn demonstrated to the farmer concerning the best methods of handling winter wheat in order to make it more successful. The important results in winter-wheat experiments will be brought together in the form of a bulletin to be published during the ensuing winter. An excellent opportunity was offered during the season of 1904 to show the superiority of winter wheat over spring wheat because of the unusually wet weather, which also favored the occurrence of a very severe attack of rust and delayed harvest time much longer than usual. The winter wheat maturing considerably earlier was able to escape the worst effects of the rust attack, and besides produced much cleaner and brighter grain.

WINTER GRAINS FOR THE SOUTH.—The development and adaptation of winter grains for the South have continued to be important lines of work. One of the most important of these grains is the Tennessee Winter barley, which has been gradually developed and acclimated from seed obtained originally from the Tennessee Agricultural Experiment Station by reason of experimental work carried on in cooperation with that station. This barley has not only proved sufficiently hardy for the worst winters throughout the South, but has now become a most promising variety for a large portion of Kansas and other districts of that latitude.

Experiments are also still being conducted with winter wheats and winter oats adapted to the South. It now seems very probable that certain varieties of durum wheat will soon become established as winter wheats in portions of the South, particularly for the production of winter pasturage. The wheat would later be cut for hay while still green, the grain itself not being used except in certain cases where it may seem desirable. This would be a new use for the durum wheats, but it is an important one, and sufficient experiments have already been made to indicate that they will probably be successfully employed in this way.

DURUM WHEAT.—In the durum-wheat industry, as a whole, only certain special features are now being investigated. There are numerous varieties, and the most important work at present is to determine which of these varieties are the best for certain localities. The most important part of this work is being conducted in cooperation with the South Dakota Experiment Station, and considerable progress in that line has already been made.

The very wet season of 1904 gave an opportunity to test the durum wheats in an entirely different respect from that of drought resistance. Durum wheats generally were known to resist rust much more than other varieties, but in all the history of this crop in the United States and in all the investigations of this Department with reference to wheat rust, there was never so good an opportunity for a severe test of these varieties in that regard. Notwithstanding the great severity of the rust attack in the Northwest, one variety of durum wheat, the

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Iumillo, remained almost absolutely free from injury. It had never been known before that a variety of durum wheat could practically withstand the worst attack of rust that is likely ever to occur. Almost all of the best durum varieties also resisted rust to a great degree, while the ordinary Fife and Blue Stem were either shriveled down to a yield of 4 to 8 bushels per acre or produced a crop not worth cutting. The details of the behavior of the different varieties of grain during this great attack of rust have been published in Farmers' Bulletin No. 219, entitled "Lessons from the Grain-Rust Epidemic of 1904."

Good results continue to be obtained with the durum wheats from a commercial standpoint. Additional mills have begun handling the grain, and in some instances farmers have been induced by the miller to grow this wheat in preference to other varieties, in order that a sufficient quantity may be obtained for profitable work.

SOUTHWESTERN DEMONSTRATION WORK.—Special attention was given the past season to the demonstration of what may be done in the production of grain on the high plains of the Southwest, including, roughly, southwest Kansas, southeastern Colorado, western Oklahoma, and northwestern Texas. The headquarters for the work are at Channing, Tex., where extensive experiments have been conducted. Special demonstrations have been carried out, however, in cooperation with some of the most enterprising farmers in different portions of this area, particularly at Groom, Channing, Dalhart, and Stratford, Tex., also near Tyrone, Okla., and Dodge City, Kans. These demonstrations were made along two lines, i. e., the introduction of drought-resistant grains and the practice of the best methods of cultivation for conserving moisture. The results have been successful, with some of the grains at least, in nearly every instance, and have been the means of awakening much interest among the landowners of that region, so that the amount of land given to cultivation will hereafter rapidly increase. It is important to note that the demonstrations at Channing were conducted during one of the driest seasons (the early part of 1904) that have occurred for many years in northwest Texas.

STUDIES OF RUSTS.—The investigations of cereal rusts carried on during the past year have been chiefly in cooperation with the Indiana Agricultural Experiment Station and have been along the line of the determination of the complete cycle of stages in certain grain and grass rusts. Probably the most important of these from an economical standpoint was the demonstration of the occurrence of the cluster cup stage of corn rust on ordinary sorrel, which now practically completes our knowledge of the life history of this rust. Other results of importance have been obtained in a study of rusts of certain economic grasses.

CHEMICAL STUDIES OF CEREALS.—The chemical investigations of cereals, all in cooperation with the Bureau of Chemistry, have been in two rather distinct lines: (1) There has been a continuation of experiments to determine the comparative baking value of durum wheat and other wheat flours, the results of part of which work have already been published in Bulletin No. 70 of this Bureau, entitled "The Commercial Status of Durum Wheat." In addition a full determination of the comparative feeding values of the most impor-

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tant varieties of oats has been undertaken, having in mind especially the value of the varieties introduced by this Department in comparison with well-known standard varieties already in cultivation. (2) A second line of chemical experiments, only begun during the latter part of the past fiscal year, is concerned with the nutrition of the wheat plant. These experiments will include studies of both the chemistry and the physiology of the plant, and, among other things, will attempt to follow especially the gradual deposition of starch, nitrogen, etc., in the developing grain.

IMPROVEMENT OF WHEAT ON THE PACIFIC COAST.—For many years the millers and grain dealers of the Pacific coast region, particularly in California, have experienced difficulty in obtaining wheat having the proper quality and quantity of gluten for producing bread flour, the situation finally becoming so bad that much wheat had to be imported from outside districts for blending with the native wheat. It is a fact that when varieties of better gluten content are introduced by the farmers they rapidly deteriorate in this quality. About a year ago the millers and other grain handlers of California determined, if possible, to ascertain the causes for this deterioration in wheat and requested the aid of the California Experiment Station in the investigation of the subject. The matter at the same time was brought to the attention of the Department of Agriculture, and in the autumn of 1904 cooperative investigations were inaugurated between this Bureau and the California Agricultural Experiment Station for the purpose of developing better varieties of wheat for the Pacific coast region, either by introducing better kinds or by the improvement of the native wheats.

CROP ROTATION AND CULTIVATION EXPERIMENTS.—Demonstration work in methods of cultivation of grains on the southwestern plains has already been mentioned. This work has, however, been made much more extensive during the year, and has been undertaken in detail at practically all of the cooperative cereal experiment stations throughout the semiarid districts. Meantime definite series of crop-rotation experiments have also been inaugurated in connection with experiments in methods of cultivation, and a specialist has been appointed to have direct charge of this work. The first year's experiments of the crop-rotation series in Kansas have already been conducted during the past season in cooperation with the Kansas Experiment Station.

LABORATORY OF PLANT PHYSIOLOGY.

Most of the energy and time of the members of the staff of the Laboratory of Plant Physiology, up to July, under the immediate direction of Dr. George T. Moore, together with a considerable proportion of the available funds, has during the past year been devoted to the distribution of cultures for leguminous crops. The water-purification work has developed in a most satisfactory way, but there are not the complete results which there would have been had the nitrogen work not consumed so much time; and other projects of considerable importance which lie within the province of the Laboratory of Plant Physiology have been necessarily neglected or only touched upon.

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NITROGEN-FIXATION INVESTIGATIONS.

The distribution of the nodule-forming bacteria carried on last year has afforded a basis for reports regarding the value of this line of work. These reports have been published as Bulletin No. 71 of the Bureau of Plant Industry, "Soil Inoculation for Legumes;" Farmers' Bulletin No. 214, "Beneficial Bacteria for Leguminous Crops," and Bulletin No. 72, Part IV, "Inoculation of Soil with Nitrogen-fixing Bacteria."

The conclusion arrived at in these publications as to the value of pure cultures in inoculating soils for legumes is drawn from about 3,500 distinct tests carried on by practical farmers and reported in form sufficiently definite to be included in a general summary. A large percentage of the reported experiments showed a gain from inoculation wherever conditions were such as to render a direct comparison possible. The evidence brought together in this way shows that the method is sufficiently simple to be practiced by any person of average intelligence, and that the bacteria are actually brought in contact with the legumes sown in such a way as to form nodules and materially assist the growth. In soils lacking nitrogen and where the nodules do not form without inoculation, the proper use of cultures makes the difference between absolute failure and a good healthy growth. Another feature brought out in the reports was the considerable gain often secured by inoculation even in soils where the bacteria were already present, as indicated by the presence of some nodules on check plants.

EXTENT OF THE DISTRIBUTION.—Since July 1, 1904, there were distributed for fall sowing in 1904 about 5,500 packages of inoculating material, making a total of 12,500 for the year. For sowing in 1905 there were distributed up to July 1 about 14,500 packages, estimated to be sufficient for inoculating 64,000 acres.

COMMERCIAL CULTURES.—The commercial production of cultures according to the method developed in this laboratory has already been undertaken to a considerable extent. Two laboratories are already furnishing cultures for all of the common legumes, and several other concerns have made known their intention to take up the manufacture. It has been the policy to furnish all necessary information to the bacteriologists representing responsible parties and to secure samples of the commercial product for examination and for check experiments, but no indorsement of any kind has been given to any concern offering cultures for sale.

INCREASING NUMBER OF STOCK CULTURES.—As soon as any demand has arisen for the organisms of a legume not already provided for, we have secured roots with nodules and prepared cultures in the proper form for distribution. In this way our stock has been increased considerably. We have cooperated to some extent in this work with the Office of Seed and Plant Introduction and Distribution with a view to securing a wider field of usefulness for a number of promising legumes, and it is the intention to further extend work of this kind. It is especially desirable to secure leguminous cover crops for use in plantations of coffee, bananas, rubber, cacao, and similar tropical and subtropical products, and to this end we are also cooperating with the Bionomist of this Bureau.

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WATER-PURIFICATION INVESTIGATIONS.

At the time of last year's report the copper method for eradicating algæ had been tested on a very few reservoirs. Since that time more than fifty water supplies have been successfully treated for algal pollution, and the experience gained under varying natural conditions has made it possible to determine more exactly the proper and necessary quantities of copper sulphate for destroying the various species of polluting algæ.

USE BY FISH CULTURISTS.—As many kinds of fish are very sensitive to the action of copper, some experiments have been carried on to determine what concentrations of copper sulphate may be safely used in water containing these sensitive varieties. At the present time these determinations have been made for eight of the species commonly found in ponds, lakes, and water supplies. Experiments begun in cooperation with the Bureau of Fisheries of the Department of Commerce and Labor have materially advanced this phase of copper treatment, and also seem to indicate that the eradication of algæ, both to improve the appearance of the ponds and to make the fish more accessible, may be very advantageously undertaken by fish culturists. It is understood that in the next annual report of the Bureau of Fisheries the use of copper will be recommended as the result of the experiments already completed.

USE IN SEWAGE DISPOSAL.—At the time of publication of Bulletin No. 64 of the Bureau of Plant Industry ("A method of destroying or preventing the growth of algæ and certain pathogenic bacteria in water supplies"), the use of copper as an agent for sterilizing a water supply contaminated with pathogenic bacteria was suggested, but it was emphasized that this was secondary in importance to the use of copper for eradicating algæ and should be regarded only as an emergency method. The occasional disastrous epidemics of typhoid fever directly traceable to uncontrollable contamination of unfiltered supplies, or to breaks or other accidents to the filters of filtered supplies, demand that this phase of the work be given more attention, and that it be recognized as of the highest importance.

A second bulletin was issued in April, setting forth the more recent facts concerning the use of copper as an algicide and disinfectant, and short accounts of its successful use both in eradicating algæ and in preventing typhoid fever at various places are included. This publication (Bulletin No. 76 of the Bureau of Plant Industry) is intended as a guide for the sanitary engineer intending to use copper.

VALUE OF THE WORK.—It is impossible to give an accurate estimate of the money value of the copper method of treatment. In some cases, as at Butte, Mont., and Winchester, Ky., where the algal pollution would have necessitated abandoning the water supply, the value may be fairly assumed as equal to the cost of the plant. The saving in these two instances considerably exceeds a million dollars, and, though they are both extreme cases, there is no doubt that the saving to other water companies, to owners of mills, and owners of cress beds, is many times this amount. Mr. Benzenberg, engineer of the new filtration plant at Cincinnati, Ohio, estimates that $480,000 will be saved by using copper to prevent algal pollution there, and it is believed that twice this amount could have been saved had the

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value of the copper method been understood at the time the original plans were drawn.

Mortality statistics are very difficult to obtain, yet a study of the Columbus, Ohio, and Anderson, Ind., cases, referred to in Bulletin No. 76 of the Bureau of Plant Industry, show clearly that the value of copper as a disinfectant may often be measured by human lives.

COPPER-IRON SULPHATE.—Special attention should be called to the application of the copper method in mechanical filtration. By request this laboratory cooperated in an experiment at Anderson, Ind., where iron sulphate containing 1 per cent of copper was used as a coagulant. The results have already been set forth in Bulletin No. 76, previously mentioned. Since that time experiments similar to those at Anderson have been successfully completed at Marietta, Ohio. In this case the results of treatment are of note chiefly because of the unusually high percentage of bacteria.

COLOR-CONTROL INVESTIGATIONS.

In cooperation with Professor Kraemer, of the University of Pennsylvania, an investigation has been begun to determine whether or not the color of flowers can be controlled to any extent by conditions of nutrition. The work has not as yet progressed far enough so that definite results can be announced.

EFFECT OF SPECIFIC SOIL ORGANISMS UPON PLANT NUTRITION.

Work to determine the effect of soil organisms upon plant nutrition has barely begun, but it is hoped that considerable strides may be made in the near future. Methods have finally been perfected which, it is believed, will enable experiments to be carried on under proper conditions. With these difficulties overcome, results of some sort should be obtained before a great while.

FLAX-RETTING INVESTIGATIONS.

Organisms obtained from Europe, together with those isolated from soil in this country, have been cultivated, and it is believed that important advances have been made in securing bacteria which will produce a maximum amount of first-class fiber in a minimum time. No practical tests on a large scale have been possible as yet, but it is hoped that such experiments, soon to be arranged for, will result in demonstrating the ease with which flax and hemp can be readily and cheaply prepared for spinning. There is no question that the proper grade of fiber flax can easily be grown in this country. There have been great advances recently in the invention of labor-saving machines for handling the retted product, and it would seem that the perfection of proper retting methods is all that is necessary to establish an industry in this country which in a short time will provide the United States with materials which now cost millions of dollars to import.

MISSISSIPPI VALLEY LABORATORY.

The work carried on at the Mississippi Valley Laboratory, under the immediate direction of Dr. Hermann von Schrenk, during the

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past year was along similar lines to that outlined in previous reports. The problems worked on and the results obtained so far may be briefly described as follows:

ST. LOUIS WORLD'S FAIR WORK.—A number of members of the staff of the Laboratory were engaged practically for their entire time from June to December, 1904, in looking after the pathological exhibit of the Bureau of Plant Industry in the United States Government Building at the Louisiana Purchase Exposition. A working pathological laboratory was maintained there, at which one member of the laboratory was constantly present. In addition to the indoor work, the out-of-door tracts of the Bureau of Plant Industry were looked after to demonstrate the methods of spraying.

EFFECT OF SMOKE ON PINE.—An investigation was carried on during the year to determine the cause of the death of white pine trees in northern New York. This work was carried on in both the laboratory and the field, and as a result of the investigation it was shown that the disease and death of the pines were due, without much doubt, to the presence of sulphur fumes in the air, coming from a sulphide pulp mill located near by. Methods for preventing the escape of these gases were studied, and work is still in progress, it being the expectation that one of these methods will practically do away with the sulphur gas.

BLUE STAIN OF WOOD.—One of the most important problems investigated was the cause and methods of preventing the so-called "blue stain" of wood. It has been found that the blue stain is due to a fungus which grows in the sapwood of conifers and certain hardwoods. From a circular letter sent out it would appear that the annual damage caused by this fungus to lumber interests would approximate $5,000,000 to $6,000,000 a year. Careful laboratory tests have shown that it is possible to stop the growth of the fungus by certain simple solutions. Field tests on a large scale have practically borne out the laboratory conclusions, it having been found possible to practically stop 90 per cent of the stain at a cost which would probably not exceed 8 to 10 cents per thousand, board measure. It is expected that full details concerning the method of prevention will be ready for publication at an early date. In view of the fact that this disease attacks wood of all kinds throughout the United States, the discovery of an effectual remedy is considered of very great importance.

DECAY OF GUM TIMBER.—An investigation was begun during the current year to determine the causes for the decay of hardwood logs, particularly of gum, in the Mississippi Valley. A peculiar form of decay annually destroys thousands of feet of gum timber cut during the months of April to October. The cause of the decay has been determined and various methods for preventing the development of the fungus in the logs have been devised, which were under test on a large scale during the summer of 1905.

DISEASES OF YELLOW PINE.—The investigations begun two years ago on the diseases of loblolly pine particularly have been completed. It has been shown by experiments that proper piling methods practically prevent the development of destructive fungi on loblolly pine. Re-

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commendations made by this Laboratory and followed out in detail were attended with the very best results in Texas and Louisiana during the last year and it is believed have resulted in an enormous saving.

DISEASES OF OAK.—Investigations have been continued to determine the cause of decay of oak timbers, and to ascertain what the conditions were which favored the development of fungi causing such decay. A clearer understanding of the physiological conditions under which wood-destroying fungi develop will in time make possible some method of prevention by eliminating these conditions.

DISEASES OF CONIFERS IN WISCONSIN.—During the summer a special investigation was made of the diseases of coniferous trees in Wisconsin. Special attention was paid to the determination of various forms of diseases, with a view to making recommendations for reducing their destructive action.

DAMPING-OFF OF FOREST TREE SEEDLINGS.—One of the most serious enemies to seed trees in nurseries has been found to be due to a form of damping-off fungus, which made its appearance in certain parts of Iowa and Nebraska during last year. A careful examination of the disease was made and spraying experiments were inaugurated. It was found that excessive mulching favored the development of the disease, and recommendations for lessening the chances of attack were made.

PHYSIOLOGICAL CHANGES WHICH TAKE PLACE IN WOOD.—The physiological changes which take place in wood when exposed to the action of water were made the subject of an exhaustive investigation. The studies were confined to two kinds of wood, which were taken in a green condition, and after long soaking in water the results of the preliminary examination have shown that considerable changes take place in the starch, sugar, and other organic contents of the wood, as well as in the cell walls, which result after a time in a reduction of the specific gravity of the absolutely dry wood. These changes are such that they will probably make the wood less liable to fungus attacks; in other words, increase the length of life considerably. The preliminary results warrant the conclusion that rafted or soaked wood will not only prove better than green wood because of lessened checking, but will also prove more decay resistant.

CROWN-GALL WORK.—For the investigation of the crown-gall disease of trees and other plants, particularly of fruit trees, work has been continued along the lines outlined in the last report. Investigations were carried on on a 4-acre tract near Louisiana, Mo., where, in addition to some 5,000 apple root grafts, 400 apple seedlings, 200 two-year-old apple trees, 100 peach, 100 cherry, and 200 plum seedlings left from the experiments in 1903 and 1904, there were planted 12,000 root grafts of 65 standard varieties of apple and 300 healthy seedling trees of a number of species of plants known to have gall diseases. In a similar experimental tract in New Mexico 3,000 grapevines were under observation, and a portion of the vineyard was sprayed with various fungicides. The results of the investigations [illegible] conclusion that the disease called crown-gall of the apple [illegible] distinct types—the true crown-gall and the hairy-root

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forms—the latter being considered a distinct disease of a more injurious form; and that the crown-gall disease of the peach, plum, almond, apricot, cherry, chestnut, walnut, raspberry, and blackberry, and probably those of the rose and grape, are contagious.

MISCELLANEOUS INVESTIGATIONS.—In addition to the problems mentioned a number of investigations directly connected with the investigations on diseases of wood were conducted at the laboratory, among which may be mentioned the study of the life history of the fungus causing the stain in timbers, investigations on ambrosia-forming fungi, and the identification of large numbers of specimens sent in by correspondents for determination and advice.

COOPERATIVE WORK WITH THE BUREAU OF FORESTRY.

FENCE-POST TREATMENT.—A method was devised by which fence posts could be treated with creosote for 3 feet at the butt end at a cost not exceeding 6 to 7 cents per post, thus giving guarantee of length of life of eighteen to twenty years or more to timbers which ordinarily would not have lasted more than two to three years. A small treating plant was maintained on the World's Fair grounds at St. Louis jointly with the Bureau of Forestry. The results have been discussed in a bulletin which has been presented for publication. It has been shown that almost any inferior wood can be successfully treated for fence-post purposes.

TIMBER-TREATING WORK.—The investigations relating more or less directly to methods of preventing the decay of wood have been carried out, as in former years, in cooperation with the Bureau of Forestry.

PACIFIC COAST LABORATORY AND WILD-PLANT IMPROVEMENT GARDENS.

The work of the Pacific Coast Laboratory and Wild-Plant Improvement Gardens, at Santa Ana, Cal., in charge of Mr. Newton B. Pierce, has been considerably extended during the year. The labor required and the material and facilities for the work in wild-plant improvement have more than doubled during that period, and this is also true of the routine work of the laboratory.

PATHOLOGICAL INVESTIGATIONS.

The wide range of plant diseases on the Pacific coast has called for the usual varied and numerous investigations and suggestions during the season, involving much laboratory work and correspondence, while special study has been made of a few plant maladies of a more serious nature.

THE CALIFORNIA VINE DISEASE.—During the year added observations have been made upon the resistance of the Lenoir grape to the California vine disease, which is the most serious and most obscure of all vine maladies. The evidence of the resistance of this grape to the disease named is becoming more and more conclusive. In the recently denuded district of the Santa Clara Valley, California, the Lenoir vine is proving its resistance as thoroughly as in southern California and in the Sacramento Valley in previous years. In pursuance

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of plans previously inaugurated, rooted vines of this variety were distributed to viticulturists throughout one of the regions of the State where the disease is known to produce its earliest and most deadly effects, the purpose being to present lessons of the hardiness of the vine before the growers. This work is already showing results by inducing many vine growers to set vineyards of the same type, all of which are proving resistant to the disease.

The work of hybridizing the Lenoir vine with a large number of other grape types, both European and American, has been prosecuted with energy. There are now growing at our gardens many hundreds of new hybrid vines, of which one parent is the Lenoir and the other parent one of the leading grape types commonly desired for cultivation. These new hybrids will be tested as to the nature, quality, and quantity of their fruit, as well as to their resistance to disease. Their hardiness will be determined by growing them in the infected region, and only those vines will be recommended which appear worthy, through their resistant and fruiting qualities, to be used as top grafts for Lenoir roots or to be grown as direct producers. During the present spring this hybridizing work has been much extended, and now includes crosses with a considerable series of the finer varieties of wine and table grapes of the State.

To further the continuance of this hybridizing work and the testing of the resistant and other qualities of the hybrids secured, a large collection of grape varieties and species has been brought together during the year and nearly 10 acres of land have been devoted to the work. This collection includes an extensive series of wine, table, and raisin grapes, as well as valuable wild species of Vitis.

The study of the effects of grafting tender grapes on Lenoir roots is being continued. The latest evidence in hand is to the effect that the life of the tender varieties thus grafted on the Lenoir vines is materially prolonged, while the result is very satisfactory where the top is a fairly hardy sort. Very extensive experiments of this nature are in progress, including not less than 400 acres of vines in northern California and a considerable acreage in other infested portions of the State. This phase of the investigation will also receive much additional experimentation by the growers in the Santa Clara Valley and of southern California.

WALNUT BACTERIOSIS.—Work on the bacterial blight of the Persian walnut has developed some new features during the year. There is some evidence that liming the soil in connection with the spraying treatment heretofore tested and recommended gives beneficial results. Whether these benefits are due to influence upon the disease by hardening the tissues affected or from increase of fruitfulness is a matter still to be investigated. The sprays recommended in treating the disease continue to show 50 per cent reduction in loss, as demonstrated by the work of the laboratory in former years. During the year a study of the action of this disease upon the late-setting French varieties of walnuts has also been made.

The effort to originate a resistant type of nut through hybridizing *Juglans regia* with other species of walnuts known to be practically immune to this disease is making progress. Many hybrids have already been secured between a number of the leading walnut species, and in some cases three-quarter bloods are already in hand. This

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work has been continued the past year as in former years, and many facts of importance in this line of plant breeding have been ascertained. Fruitful hybrids of good quality are also being obtained.

THE BERMUDA LILY DISEASE.—Hybridizing and selective work in continuation of that reported upon previously has been continued looking to the production and fixing of a strain of Bermuda lilies free from the disease now so injurious to these lilies as grown in Bermuda and elsewhere. The work has progressed far enough to confirm the results obtained by other investigators in the Bureau of Plant Industry, viz, that the disease may be eradicated by the method employed. Plants have been secured which are largely free from the marks of the malady. Efforts have already been made to establish the culture of this lily in California upon a commercial basis.

WILD-PLANT IMPROVEMENT GARDENS.

Much progress has been made the past year in developing the gardens of wild-plant improvement. The work is a popular one with the people and is attracting attention and receiving cordial support in all parts of the world. The varieties and species now growing at the gardens or which have been received as seeds, cuttings, or rooted plants from both hemispheres now form a collection of many thousands of distinct types, representing many orders of plants. These forms range in habitat from the Tropics to Alaska.

The plant-improvement work is now conducted at two gardens—A and B. Garden A is located at Santa Ana, Cal., and represents the central propagating station. Garden B is located near Fullerton, Cal., and comprises 10 acres of good sandy loam, well supplied with irrigating water, both artesian and gravity. At present this garden is largely in use as a grape-breeding station. The work is developing at a rate which, if maintained, will shortly call for a material enlargement of these facilities. The hundreds of species of forest trees from all parts of the world already growing would alone require a large tract of land to accommodate them. The wild fruits constantly coming to hand represent an extensive and very valuable collection. Many of these wild fruits are arriving at maturity, so that the work of hybridizing for improvement purposes is now being begun.

While there are many wild fruits which may require a considerable term of years for their satisfactory improvement, there are also hundreds from which early and very satisfactory results may be had. In the genus Vitis, for instance, some twenty new and valuable grapes have already been produced and are now being propagated. The fruit on some of these new vines is exceedingly fine and large, and the bunches are from 10 to 15 inches in length. This result alone warrants the outlay thus far occasioned by the entire work.

SUBTROPICAL LABORATORY.

The work of the Subtropical Laboratory is under the immediate direction of Prof. P. H. Rolfs. During the year a considerable number of tropical and subtropical plants of economic value have been received, including fruits, vegetables, fiber plants, and forage plants. These are growing upon the grounds and are being ac-

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climatized to the subtropical region. Considerable progress has been made in the study and control of several serious diseases of tropical fruits, which are briefly mentioned in the following paragraphs:

WITHER-TIP.—One of the most serious and widespread diseases of citrus fruits, known under the common name of "wither-tip," is caused by the fungus *Colletotrichum glœosporioides*. It attacks the bloom, leaf, small twigs, and fruit, and is especially severe upon the fruits of the lemon and grapefruit. Extensive experiments have been conducted during the present year on orchards varying in size from a few trees to 25 acres in extent. The results of this work show that a vigorous pruning of the diseased twigs, followed immediately by a thorough spraying with Bordeaux mixture, is a practical remedy.

CITRUS BLIGHT.—Investigations on the citrus disease known as "blight" are being continued. As the diseased trees occur sporadically, preventive means are impracticable, and curative methods will have to be developed. The method now employed by the orchardist is that of eradication and destruction. From what is known of the nature of this disease it is quite probable that curative methods will be discovered.

DIE-BACK.—In 1895 the annual loss from die-back was estimated at $100,000. Vigorous work and careful scientific studies of the cause and cure of this disease have been prosecuted. Now we are able to cure the most stubborn case of die-back at a very small cost, and the annual loss from this disease is exceedingly small. During 1895 it was not unusual to find more than 50 per cent of the trees in a region affected, most of which were entirely valueless as fruit-producing individuals. In this identical region there is now less than one-tenth of 1 per cent of the trees affected with die-back. Information regarding the treatment of this disease has been so generally disseminated that no orange grower sustains a loss greater than that portion of his crop which is grown on isolated trees, and orchards containing more than 10 per cent of trees affected with this disease are now unknown.

CASHEW BLIGHT.—A very serious disease of the cashew has developed within the last few years. By means of artificial inoculation the causative fungus of this disease (Colletotrichum) was scientifically established during the year. Meantime methods of controlling the disease were also devised. Thoroughly cutting out the diseased branches, followed by spraying with Bordeaux mixture, proves entirely efficient and practicable.

MANGO DISEASE.—During the past decade the mango bloom has been attacked by a disease which caused most of it to shed. This has been proved to be due to a fungus (*Glœosporium mangiferæ*), which also attacks the fruit in all stages of development. A thorough spraying of the panicles during the blooming season proves to be an efficient and practical remedy. This is a very unusual method of procedure, since nearly all other fruits must not be sprayed in the bloom.

CASSAVA DISEASE.—During the past year a very rapidly spreading and virulent disease, caused by a fungus (*Glœosporium* sp.), made its appearance in certain cassava fields. The practicable methods of treatment are now under consideration.

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INDIAN MANGOES.—A large number of varieties of Indian mangoes are growing on the laboratory grounds. These are being pushed in growth as rapidly as practicable. In 1901 a small inarched tree of the General Gordon mango was received, buds from which were placed into large stock, which matured a crop of fruit in 1904. This reduced the time for securing test fruits to less than half that ordinarily required.

MANILA HEMP.—Manila hemp (*Musa textilis*), which has been growing on the laboratory grounds for nearly two years, has proved itself to be very vigorous, and it is probable that the variety on hand is hardy enough to produce an excellent fiber throughout the subtropical regions where bananas are cultivated.

CASSAVA.—The 31 varieties of cassava which were introduced by the Office of Seed and Plant Introduction and Distribution have been grown, and rigid selections have been made from them. The inferior varieties are being discarded, and the 12 best are continued. Some of these are exceedingly vigorous and produce an enormous crop of starch. Other investigations are being conducted on this crop, which, when completed, will make it possible for every grower to preserve his product throughout the year.

GRAPES.—In 1900 a large number of the best European varieties of grapes, grafted on resistant stock, were planted. These were given such cultivation as is practiced in grape-growing sections. From these experiments it is proved that this plant in tropical or subtropical sections must be treated in a radically different manner from that used in the temperate regions, as all of these vines died in a short time under ordinary methods of treatment.

Another vineyard has been planted, which is now producing an abundant crop. The cultural treatment of this is entirely different from that pursued in the former experiment. The negative results obtained are of the greatest importance, however, since they teach that success must be sought along different lines of treatment.

ANONAS.—Mr. P. J. Wester, gardener of the Subtropical Laboratory, has succeeded in working out the necessary requirements for budding the sugar-apple (*Anona squamosa*) and cherimoya (*Anona cherimolia*) on the native pond-apple (*Anona glabra*). The pond-apple grows vigorously throughout regions where frosts are of frequent occurrence, while the other two species are too tender. This stock should impart a greater hardiness to the scion, making it possible to grow these delicious tropical fruits in regions farther north than the present limits. The pond-apple, being a much more vigorous grower than these other anonas, will add vigor to the buds.

VANILLA BEANS.—During the past year the laboratory has been conducting experiments on the growing and maturing of vanilla beans, from which the true vanilla extract is produced. A sufficient crop was matured to enable us to carry the product through the fermentation process and produce the article in a commercial condition. This proved to be of superior quality.

AVOCADOS.—The budding methods of the avocado, which were mentioned in the Annual Report for 1904, have made it possible to make selections from the best of those growing in subtropical regions.

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Four of these have been budded and distributed to various correspondents, together with instructions as to methods of propagation, so that they may be readily propagated and distributed in a commercial way by the cultivators of this salad fruit. From our distribution it will be possible to have ripe avocados continuously from the earlier part of July to the first of January. Under the former method of growing these from seedlings it was impossible to know beforehand what the quality of the avocado fruit would be or the date of ripening.

CITRUS HYBRIDS.—The citrus hybrids, which are being grown for the Laboratory of Plant Breeding, have received considerable attention during the year. All which are sufficiently vigorous to permit buds to be taken have been budded into rough lemon stock. A large number of the seedling hybrids have come into bearing. As soon as the fruits of these have been tested, the trees can be either discarded or their propagation extended.

PINEAPPLE HYBRIDS.—The pineapple hybrids, which include 312 distinct crosses, are now in their third generation. Rigid selection and culling are going on. Some of the numbers are of very superior quality for eating. These are now sufficiently old to make it possible to judge of their stability and vigor of growth in the field, and their probable shipping qualities. Selections will now be made with two objects in view: (1) Shipping to northern markets as a table fruit, and (2) canning.

THE HERBARIUM.

The Herbarium, which is under the charge of Mrs. Flora W. Patterson, has during the year received some valuable accessions, but owing to the expenses incident to moving into larger rooms the fund usually available for the purchase of exsiccati was considerably reduced. This has been extremely unfortunate, as in several instances the opportunities for securing valuable and rare collections were lost. The advisability of purchasing fascicles prepared by certain foreign and American mycologists, upon issue, can not be overestimated, and it is also especially desirable to secure as many "type species" as possible. The maintenance of a mycological herbarium is of great importance as an aid to practical pathological investigations, the relations between them being similar to that of a library with all lines of research work. This Herbarium is distinctly a collection for the comparisons and examinations indicated, and aside from the identifications of large quantities of miscellaneous material very little purely systematic work is done in it, its existence being for economic reasons rather than for the encouragement of the preparation of technical papers.

As heretofore, a mycological index of new species, a host index, and a pathological index of current literature, both foreign and American, are kept as nearly as possible up to date.

In the laboratory connected with the Herbarium various interests receive attention. Microscopic and cultural examinations are made in behalf of correspondents of the office. Considerable work of this nature is done for some of the State agricultural experiment stations, and many investigations have been made for the workers in Hawaii and Porto Rico. Experiments begun last year in cooperation with the pomologists of the Bureau to determine the influence of various

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temperatures upon the development of molds attacking citrus fruits in transportation and cold storage have been continued. Certain mechanical tests have been made proving the necessity of extreme care in the packing and handling of the fruits. Experiments have been made with various fungicides to prevent the development of the mold spores, which are nearly always present, and at the same time to produce by such treatment no deleterious effect upon the appearance of the fruit.

On January 1, 1905, by direction of the Chief of the Bureau of Plant Industry, a monthly inspection of greenhouses was inaugurated. Specimens of all diseased plants have been taken for microscopic examination, cultures made when necessary, and directions for treatment given to the custodian of the houses. The condition of the houses when visited in March warranted extending the intervals between inspection and reducing them to one in two months.

The danger of introducing fungous diseases with all newly imported plants has led to an arrangement with the Office of Seed and Plant Introduction and Distribution by which notice is given to this Office upon the arrival of each consignment. Such material is promptly inspected and reported upon. If the presence of a parasitic fungus is recognized or suspected, the consignment is condemned or sent to the recently established quarantine greenhouse for treatment and to await developments. Inspections are made also of all plants previous to their distribution from the greenhouses, and extreme care is taken that no diseased material be sent out. In addition to the immediate report which is required to indicate the destination or treatment of the plants, a detailed report comprising all inspections for the month is prepared for the Pathologist and Physiologist and by him transmitted to the Office of Seed and Plant Introduction and Distribution.

By recent arrangements with the pathologists connected with a number of State agricultural experiment stations for sending to this Office specimens of diseased plants, it is expected that much information will be gained in regard to the geographical range of diseases of economic importance. As the identifications of a portion of the material so received are to be made in this laboratory, a weak point in the Herbarium will be strengthened, as now many common diseases are illustrated in it by few or unsatisfactory specimens.

LIFE-HISTORY AND DRY-LAND AGRICULTURE INVESTIGATIONS.

The work of Laboratory of Plant Life History is under the immediate direction of Mr. W. T. Swingle, assisted by Mr. C. J. Brand.

DATE PALM.—During the past fiscal year the life-history investigations of the date palm have been continued and extended. Edible dates of good quality are already being produced in the cooperative date garden at Tempe, Ariz. It is gratifying to note that the varieties are behaving, as to the time of ripening, just as was predicted from a study of their heat requirements, and it is now demonstrated that the indiscriminate planting of even the best sorts of dates would lead only to disappointment and failure.

There can be no doubt that date culture is destined to have a great development in the future, and it is now probable that not only can

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the choicest varieties suitable for dessert use be produced in this country of better quality and at a lower price than they can be imported, but there is also a probability of our growers being able to supply with profit the 10,000 tons of second-class dates now imported every year from the Persian Gulf region. In order to demonstrate the feasibility of the commercial culture of this grade of dates a new date garden was established in the spring of 1905 at Yuma, Ariz., in cooperation with the Office of Seed and Plant Introduction and Distribution and the Arizona Agricultural Experiment Station. A year before a garden was established in the Salton Basin, southern California, the hottest region in North America, where the choicest late varieties of dessert dates can be brought to maturity. This garden was established in cooperation with the Office of Seed and Plant Introduction and Distribution and the California Agricultural Experiment Station.

In cooperation with the Office of Seed and Plant Introduction and Distribution, extensive investigations have been made by Mr. Thomas H. Kearney on the gathering, curing, packing, and marketing of the best dates that reach the European markets from the Sahara Desert in southern Tunis and southern Algeria. A comprehensive investigation is under way, in cooperation with the same office, on the nomenclature and horticultural descriptions of the date varieties that have been introduced and the principal sorts which yet remain to be secured.

PISTACHE NUT.—The life-history investigation of the pistache nut is well advanced, and a full report is being prepared for publication. It is now evident that this choice nut, the most costly that reaches the American markets, can be grown profitably in this country. Some of the species of wild pistaches are remarkable in being the only trees that grow to large size in the deserts of the Old World.

It has been shown that the pistache tree has a great advantage over the almond and walnut in flowering late in the spring after all danger of frost is over. It has also been discovered that pistaches grow wild in central Asia, where the winters are very severe. These pistaches have been introduced, and as they are of good color it is believed it will be possible to grow them commercially in New Mexico, Colorado, Utah, Nevada, Oregon, and Washington, where the ordinary varieties are too tender to pass the winters.

In cooperation with the Office of Seed and Plant Introduction and Distribution, a large number of seedling pistache stocks of various sorts are being grown in the Plant Introduction Garden at Chico, Cal., from which they will be distributed during the coming fiscal year to various regions where pistache culture is promising. Meantime the best commercial pistaches have been introduced from the Old World through the Office of Seed and Plant Introduction and Distribution to furnish scions for budding on these stocks.

CAPRIFIGS AND CAPRIFICATION.—The growing of Smyrna figs, which alone are suitable for drying, has become a great industry in California since the introduction of the fig insect in 1899 in connection with a life-history study of the fig. It has, however, become increasingly evident that the insect can not propagate in sufficient numbers and with sufficient security to render caprification cheap and easy unless a suitable collection of caprifigs be grown in each locality. This was

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realized early in the course of the investigation, and much importance was given to securing a proper assortment of caprifigs from the principal fig-growing regions of the Old World. As a result a very large collection of such varieties has been imported in cooperation with the Office of Seed and Plant Introduction and Distribution, and is growing in the Plant Introduction Garden at Chico, Cal., under the care of Mr. P. H. Dorsett.

CLOVER AND ALFALFA.—An extensive investigation on the life history of clover and alfalfa is being conducted by Mr. Charles J. Brand, in cooperation with the Seed Laboratory and the Office of Seed and Plant Introduction and Distribution. Clover stations, covering from 4 to 23 acres, have been established in 17 States; and alfalfa stations, from 1 to 17 acres being seeded, have been established in 10 States and in the Territory of Arizona.

It is already obvious that these experiments will yield results of the greatest interest, and that only by means of such a comparative life-history investigation can trustworthy comparisons be made as to the relative value of the different varieties and as to seed of various origin. It is clear also that such experiments are needed to decide where the best seed can be produced, and whether or not change of seed is desirable.

ELECTRO-CULTURE.—The Laboratory of Plant Life History is undertaking the study of electricity with reference to its effect on plant growth, and the possibility of the commercial utilization of electricity in horticulture and agricultural practice. Most of the literature relating to the effects of electricity on plants is of a very unsatisfactory character, and the efforts of this Laboratory have been given to the securing of a proper outfit of apparatus which will permit of the scientific determination of the effects, if any, of electricity on plants. This work is of necessity scientific in its nature, and is undertaken largely with a view to protecting the American farmer and gardener against any unwarranted claims which may be made for this or that electrical treatment for growing plants. At the present time there does not seem to be any such treatment which can be applied successfully in practice.

DRY-LAND AGRICULTURE.—The methods followed in plant life-history investigations promise to find their best field for utilization in the extension of agriculture into the semiarid and arid regions of the West. Particular attention has therefore been given to the development of methods and instruments suitable for the study of the limiting conditions which govern plant growth on the dry lands in the western United States.

Drought resistance, apparently a simple factor in dry-land agriculture, and almost universally so considered in previous publications on this subject, on analysis has proved to be a compound factor consisting of at least two very diverse elements, namely, effective evaporating surface and root pull; that is, some plants are able to live through extreme drought by cutting down their evaporation, either by reducing their evaporating surface to the minimum, as with some of the spherical cacti, or by having an epidermis almost impervious to water vapor and breathing pores capable of being tightly closed. The net result of such adaptation is to cut down to

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the minimum the loss of water from such plants, and to enable them to tide over the drought that intervenes between successive rains. The other factor, root pull, on the contrary, indicates the power possessed by many desert plants of drawing water out of heavy, dry soils; in other words, exerting very great power in pulling water out of very dry soils. An extreme example of this type is furnished by the creosote plant of the Southwest, which grows on land so dry as to preclude the possibility of the culture of any crop, and to prevent the growth of any but the most drought-resistant plants of any kind.

RELATION OF PLANT LIFE HISTORY TO BIONOMY AND WESTERN AGRICULTURAL EXTENSION.—During the past fiscal year it has become obvious that in order to secure the greatest benefit from the scientific study of the life-history requirements and limitations of plants, it would be necessary to have accurate information as to the natural history of the species to be studied, with particular reference to its capacity to react toward environment and its capacity for progressive improvement by plant breeding or otherwise. Steps in this direction have been taken.

PLANS FOR FUTURE WORK.

In planning future work it is hoped to be able to classify the investigations still more closely on the basis of specific problems or projects. This is not in all cases practicable, however, owing to the close interrelation of the various projects.

The technical and routine work of the various laboratories will be continued on the same lines as in the past. The Pathological Laboratory will examine and report on diseased material received from correspondents and field agents, isolate and study the organisms causing disease, determine methods of infection, etc.

The special work on diseases of orchard fruits will be continued. The pear-blight eradication work in Georgia will be turned over to the State horticultural inspector, and every assistance will be given him by way of advice in planning and carrying out the campaign of eradication which we have shown to be practicable. Our own experiments or demonstration work will be conducted next year in southwestern Colorado and in California. In the latter State the work has already been started and is receiving the hearty support of the State experiment station and the horticultural commissioners. The field demonstrations on "little peach" we expect to complete during the present season, and the work will then be turned over entirely to the State experiment station or to the State inspector of nurseries and orchards for general applications. The work on the brown-rot of peaches and the bitter-rot of apples will be continued by Mr. W. M. Scott. Mr. P. J. O'Gara will work out the life history of the new apple canker and the disease known as "black-heart," and as much work as practicable will be done on the root-rot of fruit trees.

The work on sugar-beet investigations will be a continuation of the problems already in hand, including a study of the various sugar-beet diseases, with special reference to cause, where not already determined, the means of transmission from field to field and from season to season, and finally the best methods for their suppression and control. The work on the production of single-germ beet seed will be continued,

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and also the improvement of sugar beets in quality, both by means of fertilizers and by selection. Other problems for consideration will be the production of early strains or varieties for the purpose of lengthening the harvest time, selections for the purpose of obtaining a strain of beets resistant to alkali, and investigations in regard to methods of siloing.

The work of perfecting disease-resistant melons will be continued, 10 acres of this new variety being cultivated at Monetta, S. C., for the purpose of making selections, and a similar area at Auburn, N. C., in cooperation with the North Carolina Agricultural Experiment Station. The work on the improvement of the wilt and root-knot resistant varieties of the cowpea will be continued; also the study of pecan diseases. Special attention will be given to the study of potato diseases, and especially to testing the various resistant varieties which have been imported through the Office of Seed and Plant Introduction and Distribution. The potato experiments are being carried out in cooperation with the experiment stations of Vermont, Colorado, Oregon, and Florida. Breeding for resistance to potato rot will be given special attention at the Vermont Experiment Station. The work on the root-rot of cotton and alfalfa will be continued on the same lines as in the past, and demonstrations and spraying experiments on the methods of controlling cranberry diseases will be made in the cranberry sections.

The investigations of the diseases of crops caused by nematodes will be continued, with special reference to finding means of freeing the soil of these pests and to the development of resistant varieties of crops.

The work of the Laboratory of Plant Breeding, with slight changes, will be continued on the lines already laid out. Long-staple cotton hybrids will be selected to secure complete fixity of type, and will be propagated for distribution as soon as they have reached this condition. Next season some of these hybrids will be placed with growers for more extended tests under different conditions. Egyptian cottons will be thoroughly tested in the southern part of the cotton belt. The breeding of early and more productive strains of ordinary short-staple varieties will be continued and pedigree strains produced for distribution.

The new varieties of citrus fruits will be distributed to growers for further trial and introduction. Experiments will also be continued with hybrids which have not yet fruited. It is intended this season to plant a trial grove of two trees of each hybrid.

New varieties of pineapples considered to be of value will be propagated as rapidly as possible in order to secure enough plants for distribution.

Work in the improvement of oats will be continued in the Mississippi Valley States along the same lines as last year. Worthy new sorts obtained will be propagated extensively to increase the quantity of available seed. Cooperative work with the Iowa and Wisconsin experiment stations will be continued, special attention being given to the production of smut-resistant and nonlodging sorts.

Selected varieties of corn, which have proved their worth in actual tests, are being grown on a fairly large scale this year in order to secure sufficient seed for distribution to intelligent growers in various

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sections for trial and introduction. Tests of varieties in cooperation with northern and southern experiment stations will be continued and should yield data of considerable interest for comparison. To secure better varieties of corn for southern conditions is a problem of the greatest importance, and will be given careful attention. The production of varieties of sweet corn suitable for cultivation in the South and better canning sorts for the North will be continued on a somewhat larger scale.

The investigations of crops in their relation to saline and alkaline soils will be continued. Attention will be directed, as heretofore, chiefly to the securing by breeding of resistant strains of the principal field crops. Work of this kind with alfalfa, wheat, barley, oats, and sugar beets will still go on, and will be commenced with sorghums and possibly other crops. Arrangements are being perfected to test the alkali resistance of different varieties of the date palm imported by the Bureau of Plant Industry. Useful plants imported from foreign countries by the Office of Seed and Plant Introduction and Distribution will be investigated as to their alkali-resisting qualities. Laboratory experiments as to the effect of alkali salts upon plants will be extended by using soil cultures in addition to water cultures, special attention being paid to the comparison of different varieties of the same crop plant with a view to determining which are best adapted to different types of alkali soil.

Tobacco experiments in the Connecticut Valley will be continued and seed of the various new sorts produced and placed in the hands of growers for cultivation. Every effort will be made to spread the knowledge of the methods of seed selection and separation devised, so that farmers will generally adopt them in the improvement of their crop. Further experiments will be made with promising hybrids of the native types of Broadleaf and Havana seed with the imported wrapper types of Sumatra and Cuban tobaccos.

In Florida and southern Georgia the production and introduction of more uniform strains will be continued. The selection of better filler types was begun this spring, and next year it will be known what can be expected from it. Further selections will also be made of plants resistant to root-rot or nematodes, for further trial next year.

Improved types of Maryland export and smoking tobaccos will be tried in more extended field culture in cooperation with the State experiment station and growers. Every effort will be made to secure seed of the better yielding types for general use. Improved hybrid types will be further tested, and later introduced into cultivation should they be found to maintain their good qualities.

In addition to the work already under way, it is of the utmost importance that experiments be undertaken in the improvement of the varieties of tobacco now grown in Kentucky and Ohio. In both of these States some of the most vital problems in plant breeding are to be solved. It is hoped that experiments may be undertaken in these sections next year.

In Cereal Investigations special attention will be given to the subject of winter-wheat extension along the same lines as conducted the past season. Work on the development of winter grains for the South will be continued. The investigation of grain rusts will be continued, in part in cooperation with the Indiana Agricultural

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Experiment Station and in part in the northwestern wheat area, where special attention should be directed to breeding for rust resistance by using the resistant varieties of durum wheat as one parent.

The investigations in cooperation with the Bureau of Chemistry to determine the cause of the deterioration in the milling qualities of wheat will be considerably enlarged. The cooperative experiments started last year with the California Agricultural Experiment Station looking to the improvement of wheat on the Pacific coast will be continued upon the same lines as already described in this report.

Demonstration work in methods of cultivating cereals in the semi-arid region will be continued in cooperation with the State experiment stations. This work will include the determination of the crops to be used in rotation with wheat or other cereals.

In the Laboratory of Plant Physiology the distribution of nitrogen-fixing organisms to be used in connection with leguminous crops will be continued to about the same extent as during the past year. If additional funds are provided the distribution can be considerably extended. If funds are available it is desired to give special attention to developing the nitrogen-fixing powers of a group of organisms which work independently of any special crop.

It is hoped to continue also the investigations relating to the use of copper in the purification of water supplies. It is planned to extend the investigation on the effect of specific soil organisms upon plant nutrition. This is a branch of soil bacteriology which has been very imperfectly developed, but it is a question of the greatest importance in connection with the maintenance of soil fertility and the availability of plant foods in the soil.

The investigations on flax-retting organisms will be continued, and it is hoped that some practical tests of the organisms isolated can be made during the year.

At the Mississippi Valley Laboratory special attention will be given to the completion of the investigation of crown-gall, and it is hoped that valuable results will be obtained from the extensive field tests now in progress. The work on the methods of preventing the various rots of forest and construction timber will be continued, and methods of preventing the bluing of sawed lumber will be tested on a practical scale.

The work at the Pacific Coast Laboratory and Wild-Plant Improvement Gardens will be continued with special reference to the development of varieties of grapes resistant to the California vine disease, and the further testing of the resistance of the Lenoir stock. In the study of walnut bacteriosis special attention will be given to the effect upon the disease of liming the soil, as past observations indicate that liming has a decided retarding effect on the development of the malady. The work on the production of resistant varieties of walnuts will also be continued.

The work on the improvement of wild fruits will be continued on the same lines as already laid down.

The work at the Subtropical Laboratory in Florida will be continued with special reference to the study of the diseases of citrus fruits and truck crops in that region.

The investigations in dry-land agriculture will be continued on the same lines as at present followed.

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FARM MANAGEMENT.

As heretofore stated, the Office of Farm Management as recently organized is in charge of Prof. W. J. Spillman. This Office is concerned primarily in the adoption of proper business principles in the conduct of the farm. A study of the most successful farms in the country indicates clearly that one of the most important business principles in farm economy is the utilization of the knowledge gained through scientific investigation; hence a very important part of the work of this Office consists in aiding the farmer to put into practice what science has learned in his behalf.

A careful study of farm practice will not only result in the discovery of many facts and principles of great importance, but it will unearth endless problems for the scientific investigator. It will show the scientist what the real problems of agriculture are. The investigator in agricultural science is not in a position to render his efforts of the greatest value unless he is close enough in contact with the farmer to know what his real difficulties are. The Office of Farm Management is therefore to be, in two senses, a bridge connecting farm practice and the laboratory of the investigator. It will carry to the farm the facts learned in the laboratory and it will aid the investigator by showing him where his efforts are most needed. At the same time this Office becomes a clearing house of information gleaned from a study of the experience of farmers, and thus enables the farming public to secure the benefits to be derived from the experience of successful individual farmers all over the country.

The lines of work undertaken by the Office of Farm Management may be grouped into two divisions: One consists in acquiring valuable information by the study of farm practice and the results of scientific investigation; the other consists in efforts to aid the farmer in improving his methods. In point of time the development of the latter phase of the work has preceded the former, this being made possible by the great body of well-established facts in agricultural science. Work of this character was also more urgent, particularly in the section where the advent of the Mexican cotton boll weevil rendered necessary a radical change in farm methods. The more logical sequence will be adhered to in the following presentation of the work of the Office.

STUDIES OF FARM PRACTICE.

The following definite studies of farm practice have been inaugurated:

METHODS OF TILLAGE.—The work on methods of tillage has been assigned to Mr. Harold T. Nielsen. The method of preparing the soil and of tilling crops in vogue in different sections of the country will be studied. The first object in view is to secure a knowledge of actual practice, in order to ascertain where improvement is most needed. Particular attention will be given to the relation between methods of handling the soil and the various soil types; also to the relation between tillage practices and climatic conditions. It is hoped that this study will give us a better knowledge than we now

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possess concerning methods that are most successful in various parts of the country. It will certainly result in finding many problems for the experiment stations and the specialists of the Department.

SOILING SYSTEMS AND SILAGE MAKING.—The studies of soiling systems and silage making have been assigned to Mr. Lyman Carrier. An effort will be made to secure an account of the soiling systems practiced on successful farms in all sections of the country on which a satisfactory system has been worked out. The crops used, dates of planting, dates when each crop is available for use, area of each crop required for herds of a given size, and the stage at which each crop is cut are to be studied. Records will also be made of the relative value of all such crops, as indicated by the experience of feeders. In the study of silage making, attention will be given to the crops used, time of cutting, number and distribution of laborers in storing silage, machinery used, and the cost of storing. Mr. Carrier will also give attention to the methods of handling silage in feeding, the place silage occupies as a feeding stuff, and the types of silos in use, their cost, convenience, and durability.

MANURES AND FERTILIZERS.—Notwithstanding a century of careful experimenting with commercial fertilizers, we are still very far from an understanding of them that will enable us to advise farmers with confidence regarding their use. Mr. Leroy C. Wilson has undertaken to collect information concerning farm practice with fertilizers and manures. Whether any useful deductions can be made from the study of the actual use of commercial fertilizers by farmers remains to be seen. It is believed, however, that such a study will reveal important relations between fertilizers and soil types, and will point the way to experiments that will result in at least a few guiding principles upon which the farmer may rely with confidence. Mr. Wilson will study the kind and quantity of fertilizers used for different crops on various soils, time and manner of application of the fertilizers, and their cost. He will also visit a large number of the most successful farms of the country and record carefully the methods used in handling farm manures.

ALFALFA AND CLOVER INVESTIGATIONS.—In connection with the work on alfalfa and clover extension for the Office of Seed and Plant Introduction and Distribution, Mr. J. M. Westgate will conduct studies on farm practice with this class of plants for the Office of Farm Management. It is the object of this study of farm practice to learn all that is possible regarding these important crops from the experience of farmers. Much attention will be given to the relation of cultivation of legumes to soil types. Particular attention will be paid to types of soil on which alfalfa thrives, and an effort will be made to ascertain the condition required for getting alfalfa started on soil types on which it has been difficult heretofore to establish this crop. Data will be gathered concerning the preparation of soil, date and rate of seeding, manner of seeding, use of nurse crops, yield, and manner of utilization of the crop on the farm, and the relation of the alfalfa crop to ordinary farm rotations also will be studied. These studies will necessarily include a careful investigation of the distribution in various parts of the country of all of the crops concerned.

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STANDARD GRASSES.—In connection with his investigations for the Office of Seed and Plant Introduction and Distribution, Mr. R. A. Oakley will study farm practice with reference to the standard grasses. He will note the grasses that are made use of by the farmer for hay and pasture purposes throughout the country, and will give attention to the practice of farmers in the matter of seeding, pasturing, harvesting for hay, and in the management of meadows and pastures, and to the position of the various grass crops in the cropping system of the farm. He will make careful note of the esteem in which the various grasses are held by those who grow them, and gather data concerning their standing on the markets.

TYPES OF FARMING AND THEIR RESULTS.—In order to ascertain what types of farming are followed in the various sections of the country, to learn the results secured from different systems, to find the most successful farms, and to arrange for the cooperation of farmers and station workers in conducting object lessons in farming for the benefit of other farmers, five representatives of the Office have been assigned to particular sections of the country, as follows: C. W. Warburton, Texas; D. A. Brodie, Louisiana and Arkansas; M. A. Crosby, Mississippi, Alabama, and Tennessee; Harmon Benton, Florida, Georgia, South Carolina, and North Carolina; Lawrence G. Dodge, New York and the New England States. These men study the types of farming followed in the section to which each is assigned; they study the results of the investigations of the experiment stations; they seek out the most successful farmers and make a careful record of the details of their system of management. In special cases they will prepare bulletins on the work of particular farms, but the publication of the results of these studies will ordinarily be more general in character. In special cases of particular public interest, records of the details of work on particular farms covering a period of years will be made.

DIVERSIFICATION FARMS.

As a means of awakening interest in better methods on the part of farmers, a number of the object-lesson farms referred to have already been established and others are contemplated. As these farms are for the most part located in sections in which single-crop systems of farming prevail, they have been called diversification farms, in order to emphasize their purpose. In a section where farmers are wedded to a poor system and have no great faith in the so-called improved methods urged upon them, the great value of making use of an unusually profitable farm as an object lesson is readily seen. Even in the sections where the best type of farming prevails, the methods used on any farm that is more profitable than the average are always of interest to the farmer. Many farmers believe that much of what they hear from teachers of agriculture is impractical, but when they see these teachings actually applied and producing better results than they themselves secure they readily admit the value of improved methods.

A distinction must be made between these diversification farms and the plat or crop demonstrations which are a feature of the work of many of the experiment stations. As an illustration of the distinction may be taken the excellent system of demonstration stations

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maintained by the Oklahoma Experiment Station. On these stations plats of alfalfa, Kafir corn, etc., are maintained for the purpose of teaching farmers that these crops can be successfully grown, as well as the best methods of growing them. These demonstrations grow naturally out of the field work of the experiment stations and are a valuable means of carrying the results of experiments to the farmer, but they do not constitute a farm. The aim of the diversification farm is to attract the attention of farmers by the profit the farm makes. Each one represents a particular type of farming, and no attempt is made to make crop demonstrations, except in the case of the crops actually needed in the system of farming followed. The farms are therefore greatly limited in the number of lessons each can convey to the farmer. They are conducted for the purpose of making large profit to the owner, thereby attracting attention to the methods used.

The general plan pursued in locating and organizing the farms is as follows: The supervisor of a district studies the type of farming prevailing in his territory, and seeks those farms which are conducted in the best manner. During this investigation he consults freely with the experiment-station workers, farmers, institute conductors, and others having a knowledge of local conditions. Having determined the types of farming which it is most desirable to encourage, and having found the most successful farms of this type, arrangements are made with the owner of one or more of the best conducted farms to secure a detailed record of work for a period of years, and for conducting farmers' institutes on the farms. These institutes are to be held in cooperation with the regular institute conductors of the State. The supervisor of the district visits the farms periodically and looks after the records. Copies of these records are furnished to the Bureau of Plant Industry and to the State experiment station concerned.

In many cases it has been necessary to make more or less modification in the system followed on the farm selected. In such cases the advice of the experiment-station authorities is sought. In some instances local experiment-station men plan the details of the system to be followed on the farm, and in all cases in which they can give the necessary time such plans are submitted to them for approval.

District No. 1.—District No. 1, of which Mr. C. W. Warburton is supervisor, includes fourteen of the sixteen Congressional districts of Texas. Ten diversification farms have been organized in it. In the Thirteenth Congressional district, including the Panhandle country, conditions were such as to call for experimentation rather than object-lesson farming. Accordingly experiments with a view to securing more and better crops adapted to local conditions were undertaken in cooperation with the Texas State Experiment Station, Mr. A. B. Conner, of that station, having immediate charge of the experimental work. As it is not a part of the work of the Office of Farm Management to conduct experiments, this work is in charge of the Office of Seed and Plant Introduction and Distribution of this Bureau. Two farms remain to be located and organized in this district. Of the ten farms in operation, the one at Arlington, Tex., was organized in March, 1904, the others being established in the autumn of 1904.

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Three of these are truck farms, three are devoted to mixed farming and stock raising, two to dairying and hog raising, one to trucking and hog raising, and one entirely to hog raising. It is yet too early to present any valuable results from these farms. The past winter season was the most severe ever known in Texas, and many fall-planted crops were killed. A large area of alfalfa has been successfully seeded on the farm at Arlington, and a good profit is fairly well assured on this farm the present season. The farm has already made some profit on hogs and cotton.

District No. 2.—The second district, with Mr. D. A. Brodie as supervisor, includes the States of Louisiana, Arkansas, and two Congressional districts in Texas. The only farms yet operating are the two in Texas. Eight others have been definitely located in Louisiana, the selections having been made by Prof. W. R. Dodson, director of the Louisiana stations, and Mr. Brodie. Four more will be located this season, two in Louisiana and two in Arkansas. It is hoped that all these farms may be organized in time to begin operations this fall.

District No. 3.—The States of Mississippi, Alabama, and Tennessee constitute the third district, of which Mr. M. A. Crosby is supervisor. Diversification farms are in operation in these States as follows: Mississippi, 3; Alabama, 3. During the present season 3 others will be organized in Mississippi, 3 in Alabama, and 2 in Tennessee. The types of farming represented by those now in operation are: Mixed farming and stock raising, 2; hog raising, 1; trucking, 1; dairying, 1; beef production, 1. Acknowledgments are due to the experiment-station staffs of Mississippi and Alabama for assistance in the organization and conduct of the farms in those States. The planning of the work on the beef farm at Courtland, Miss., has been entirely the work of Prof. E. R. Lloyd, of that State, while Prof. J. F. Duggar, of Alabama, has rendered much valuable assistance in connection with all the diversification farms in that State.

The farm at Uniontown, Ala., devoted exclusively to hog raising, is the only farm in this district that has been in operation for a full season. The results on this farm are exceedingly gratifying. The owner, Gen. T. T. Munford, has made more money from the 45 acres farmed on plans suggested by Professor Duggar and the Department than on any other area of twice the size on his large plantation, while the character of the farming is such as to build up soil fertility rapidly. One hundred and thirteen hogs pastured on 7 acres of alfalfa this spring have made gains that net $10.35 per acre per month, after deducting the value of the grain eaten. Eight acres of alfalfa cut for hay have already produced 30½ tons of prime hay this season (before June 12, 1905). This alfalfa was sown in the spring of 1904. The success of the methods employed on this farm has already had a marked influence on the diversification of farming on the prairie soils of central Alabama.

District No. 4.—District No. 4, Mr. Harmon Benton, supervisor, consists of the States of Florida, Georgia, South Carolina, and North Carolina. One farm in this district was organized at Columbia, S. C., in the spring of 1904. Since then two others have been organ-

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ized in South Carolina, two in Georgia, and one has been located in North Carolina. Others are to be organized this season, as follows: Two in Florida, two in Georgia, one in South Carolina, and one in North Carolina. Director Redding, of the Georgia Station, has rendered valuable assistance in outlining the cropping system of the farm at Hogansville, Ga., and Director Kilgore, of North Carolina, secured the location for the farm in that State. The organization of this farm will be effected in the near future. Three of the farms in this district are devoted to mixed farming and stock, one to dairying, and one to dairying and trucking.

District No. 5.—This district consists of New York and the New England States. Mr. Lawrence G. Dodge, who has been made supervisor, is just beginning his work in this territory. He will devote himself to a study of the types of farming prevailing in that section, and will give particular attention to the methods of successful farming on worn-out soils. Complete records will be made of the system of management found on the most profitable farms throughout the district.

Truck crops.—The work with truck crops on the diversification farms is in charge of Prof. L. C. Corbett, Horticulturist of this Bureau. He advises regarding the crops to grow, methods of growing, marketing, etc., and provides the necessary blanks for keeping records of the work with truck crops. Arrangements have recently been completed for securing the entire time of a specialist in truck farming in connection with this feature, to work under the direction of the Horticulturist. The Dairy Division of the Bureau of Animal Industry has cooperated with this Office in the most cordial manner in the conduct of dairy work on the diversification farms.

GRASS AND FORAGE PLANT INVESTIGATIONS.

The Grass and Forage Plant Investigations of the Bureau, under the direction of Prof. W. J. Spillman, have continued during the past year along essentially the same lines as during the year preceding. Particular attention has been given to a continuation of the extension of alfalfa culture in the Eastern States. Some notable advances have been made during the year in our knowledge of the uses and value of cacti as forage plants. Practical implements for removing the rootstocks of Johnson grass from the soil have been devised. Our study of the horticultural varieties of soy beans, cowpeas, and sorghums has been practically completed, so far as varieties grown in this country are concerned, and the results of this study will soon be ready for publication.

The following is a brief statement of the more important investigations of the Office for the year:

Alfalfa and clover investigations.—Investigations relating to the class of leguminous crops comprising alfalfas and clovers were conducted by Mr. A. S. Hitchcock during the early part of the year. Upon his assuming charge of the agrostological herbarium the alfalfa and clover investigations were undertaken by Mr. J. M. Westgate. Work has been continued with numerous varieties of alfalfa and clover with special reference to their adaptability to

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the diverse conditions prevailing over the wide area in which these crops are cultivated. A systematic effort is being made to determine the requirements of these crops with reference to soil, fertilizers, time of seeding, use of nurse crop, inoculation, and subsequent treatment. The results already obtained indicate that the chief problem in connection with these crops is the determination of their cultural requirements under the varying conditions of soil and climate.

Cooperative experiments have been undertaken with the experiment stations in Connecticut, Georgia, Louisiana, Massachusetts, Maryland, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, North Carolina, North Dakota, Ohio, and South Dakota, and these will be continued during the ensuing year. The principal object of these experiments is to determine the best methods of establishing this valuable class of leguminous crops under various soil and climatic conditions.

It has been found that sweet clover (*Melilotus alba*) is a valuable forage plant in certain sections of the country, and work has been commenced to extend the culture of this crop, especially upon the black waxy lands of Texas, and to determine the reason why stock eat this plant readily in some sections, but refuse to eat it in others. Its rank growth, together with its readiness to grow on the poorest soils, would render it of great value in many sections of the country if the natural dislike for it shown by stock can be overcome.

RANGE INVESTIGATIONS.—The study of range problems during the year has included the preparation of a map showing the distribution of cattle and sheep on the western ranges, and a study of the carrying capacity of various parts of the range country. Experiments in reseeding denuded range lands in the mountains of central Washington have been entirely successful. As a result of these experiments large areas of range lands have been seeded by stockmen. Methods of management of several large ranches have been carefully observed, and Mr. David Griffiths and his assistant, Mr. J. S. Cotton, have rendered much assistance to stockmen by giving information on the proper management of native grass lands in the range region. The 50-square-mile tract of denuded range land on the Santa Rita Forest Reserve in Arizona, fenced two years ago and kept free from stock since that time, has regained its former coating of vegetation, and much of it would this year have furnished a profitable crop of hay. As in the preceding year, careful records have been made of the quantity of feed produced on many small selected areas of this tract.

Investigations on range improvement in the State of Washington have been continued in pursuance of plans outlined in the last report. Careful notes were made on the condition of the experimental plats on the Wenatchee Mountains of central Washington. The experiments on these plats demonstrated that timothy can be very profitably sown in the overstocked mountain meadows, where it will produce more feed than grew in such areas before they were first grazed. The experiments indicate that *Bromus marginatus*, *Bromus inermis*, *Festuca elatior*, and probably *Dactylis glomerata*, in the order named, will be of great value in the more gravelly soil surrounding these meadows. *Bromus marginatus* will grow well on the gravelly side

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hills. These experiments also demonstrate that while these grasses can be seeded in the autumn successfully without further treatment the cost of harrowing in the seed will be well repaid by the extra stand secured thereby; also that grasses seeded in the spring must be covered by harrowing in, if they are to be successful, as the surface of the ground dries very rapidly after the snow disappears.

Careful investigations were also made of the grazing conditions in the pastures on the neighboring ranges. The condition of these ranges indicates that they are overstocked. The results of these observations and experiments have been published in Bulletin No. 75 of the Bureau of Plant Industry.

During the spring of 1905 a careful reconnoissance was made of the forage conditions of Inyo and Kern counties, Cal. The regrassing of the ranges in this section is considered to be practicable.

In connection with our investigation of the carrying capacity of the western ranges, a considerable number of stockmen are, at our request, keeping records of the amount and kind of stock on their ranges, and the length of time they remain on a given range. These records cover ranges from South Dakota to California and Washington.

GRASS LANDS OF THE SOUTH ALASKA COAST.—During the season of 1904 Mr. C. V. Piper, in cooperation between the Bureau of Plant Industry and the Office of Experiment Stations, investigated the grass lands of the south Alaska coast, to report upon the possibilities of their agricultural utilization. The greater portion of the Alaska coast region from Cook Inlet to Unalaska, consisting of about 10,000 square miles, is composed of more or less mountainous lands, but with considerable areas approximately level. On the best of this land there is a luxuriant growth of grass, often 6 feet high. On the remainder, lying at higher elevations or in more exposed situations, the grasses are considerably shorter, but furnish very fine pasturage.

Sheep husbandry on these lands has thus far not proved successful. This may, perhaps, have been due to the fact that the breeds experimented with were brought from warm and semiarid climates and were therefore not well adapted to the moist conditions of the Alaska coast. With other breeds it is not at all unlikely that success might be achieved.

Cattle raising, on the contrary, is attended with practically no difficulties, the principal drawback being the rather long feeding period, which will average five months of the year. Owing to the limited Alaskan market and the high freight rates, it does not seem probable that the raising of cattle for beef can develop into much of an industry under present conditions. On the other hand, it is believed that the manufacture of butter and cheese is likely to be markedly successful. With concentrated products such as these, the freight rates are not a serious factor. Furthermore, with dairy cattle some return may be had during the necessarily long feeding period. The putting up of hay for winter feed is unusually difficult, owing to the very moist climate, but experience has shown that this can be obviated by the putting up of grasses, at least the more succulent ones, as silage. The results of these investigations are embodied in Bulletin No. 82 of the Bureau of Plant Industry.

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INVESTIGATIONS ON STANDARD GRASSES.—Continued studies of the new varieties of timothies developed by Dr. A. D. Hopkins, which we have carried on both at the Arlington Experimental Farm and at Pullman, Wash., show that these varieties hold their distinctive characters very constantly and reproduce true to seed. The three most important varieties, viz, Stewart's Mammoth and Extra Early, both of which are primarily for meadows, and the Pasture variety, particularly adapted for pasture, have been grown in as large areas as the quantity of seed available would permit. As a result it is hoped this year to have a supply of seed sufficient to distribute to various parts of the country for further experimental work.

Similar work in the selection of important varieties of orchard grass, meadow fescue, and smooth brome-grass has been carried on at Pullman, Wash., by Mr. Byron Hunter. These varieties likewise come true to seed and show marked improvement over the ordinary strains. Just as rapidly as is possible a supply of seed of these grasses will be grown for general distribution.

Some of our best grasses, although by no means new or untried, are not at present grown throughout the sections of the country to which they are undoubtedly adapted. Considerable attention is being paid to the exploitation of certain grasses in such sections. The species to which the most attention has been given are *Bromus inermis* and *Festuca elatior*. The former is grown extensively in the prairie regions of the Northwest, but is evidently a valuable pasture grass throughout the North. The latter is rapidly gaining in popularity in central and eastern Kansas, and its cultivation in a wider territory would apparently add much to forage resources. *Agropyron tenerum*, a native of the Northwest, which has been brought under cultivation within a comparatively recent period, is also being exploited in sections that are apparently adapted to its growth.

Experiments with standard grass mixtures for meadow and pasture purposes have been conducted during the year with a view to finding mixtures that are best suited for various soil and climatic conditions. Further investigations are in progress for the purpose of determining the best methods of handling hay meadows and pastures, including seeding and maintaining them in a state of high productivity. Much information concerning the best farm practice with tame grasses has been obtained from successful farmers through the tame-grass section.

DOMESTICATION OF NATIVE WILD GRASSES.—One of the greatest problems that confront the farmer and ranchman west of longitude 97° west is the securing of forage crops that will furnish feed for stock under the adverse conditions that exist. The demand for drought-resisting grasses that can be grown for hay on land that can not be irrigated is especially important. The standard grasses can not be grown successfully on the greater part of the arid and semiarid regions and in consequence fill the demand only in more favorable localities. With a view to finding grasses that are able to withstand the conditions of the region referred to, the Office of Grass and Forage Plant Investigations is at work upon the problem of domesticating native species that seem to be most promising for this purpose. This work is conducted by Mr. R. A. Oakley, largely in cooperation with farmers and ranchmen who grow the grasses under ordinary field conditions. While the problem of domesticating native wild grasses

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concerns the West primarily, there are portions of the East where certain of the drought-resistant species most common to the West seem to be well worth exploiting. The results of last season's experiments with such grasses in the East justify more extensive work, and reports from cooperators have been very favorable, especially in regard to species of Agropyron, Elymus, and Bouteloua. One species, western wheat-grass (*Agropyron occidentale* Scribn.), above all others seems to warrant considerable attention. It is a native of every State west of the Mississippi River, but is most abundant in the Northwest. Under irrigation, in parts of Montana it makes an excellent crop of hay. Its excellent seed habits have made it possible to select varieties that are of agricultural importance. It is a notable fact that on markets where hay from this grass is well known it sells for higher prices than the best grades of timothy hay. Some of the Elymus species give promise of being important as hay grasses on dry lands that receive an overflow once a season but are otherwise unirrigated; also on bench lands. There are other very promising species, but none of these has been handled as yet on as large a scale as those mentioned. This work is to be conducted in the future in cooperation with the Office of Seed and Plant Introduction and Distribution.

SALTBUSHES.—During the season of 1904 Mr. C. V. Piper was detailed to find out to what extent the saltbushes were at present being utilized in agriculture, more particularly the Australian saltbush (*Atriplex semibaccata*). More or less experimentation has been conducted with the saltbushes for about twenty years, and there is still a large interest in these plants as a possible crop for alkaline lands. The most striking result of these investigations has been the fact that we have not succeeded in finding a single farmer who is growing any one of the saltbushes as a crop. In connection with the previous experiments, especially in California, it has been found to be quite practicable to grow the Australian saltbush under cultivation and to obtain very satisfactory crops. No experiments have yet been carried on, however, to discover how the crop can be profitably utilized. This is, of course, necessary before it can be hoped to introduce the crop into practical agriculture. In limited portions of California the Australian saltbush has escaped from cultivation and is more or less aggressive as a weed. In such cases live stock seem to show little liking for it. It is very probable, however, that the plant can be utilized as a profitable feed for both sheep and hogs, but, as before stated, investigations on this subject are much needed. It is hoped that in the near future it will be possible to conduct experiments that will bring to a definite conclusion the large numbers of preliminary investigations which have been made on this plant.

CACTUS INVESTIGATIONS.—Mention was made in the last annual report of the possible value of the cactus plant for forage and other purposes. During the past year Mr. David Griffiths has conducted extensive investigations on this subject. A detailed study has been made of the experience of stockmen who have used cacti, particularly in southwestern Texas, where these plants are extensively fed. They constitute the principal feed of the cattle used as draft animals by Mexican freighters in that section. As an emergency ration in years of famine, the variety of cactus known as the prickly pear is

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held in high esteem by cattlemen throughout the region in which it is abundant. Many instances have been found in which vast herds of range cattle have been carried safely through periods of extreme drought by feeding this plant. It is estimated by some of the leading stockmen of Texas that the carrying capacity of their ranges has been doubled by the discovery of satisfactory methods of feeding cacti. With this reserve of feed, available whenever needed, it is safe to stock the ranges to their full capacity in ordinary years without fear of serious losses in dry years.

Two methods of feeding cacti are used extensively in southwestern Texas. Either the spines are removed by scorching, for which practicable implements known as "pear burners" are in use, or the plants are run through "pear cutters," which operate much as an ordinary feed cutter. The latter process macerates the spines to such an extent that they become almost entirely innocuous.

In the vicinity of San Antonio, Tex., several dairymen have been found who regularly use the prickly pear in the ration of their cows, particularly during the winter months, at which season the cacti are at their best for feeding purposes. This is fully discussed in Bulletin No. 74 of the Bureau of Plant Industry, entitled "The Prickly Pear and Other Cacti as Food for Stock." During the year preliminary feeding experiments have been conducted to test the value of cacti as feed both for beef cattle and for dairy cows. These experiments indicate that these plants have a feeding value comparable with that of the same quantity of dry matter in the ordinary feeding stuffs.

In those sections in which the prickly pear is most abundant sufficient material has been cut from 1 acre of land to furnish all the roughage needed for 10 head of cattle during a period of six months. How often such crops can be harvested is not known, but investigations to determine this point have been instituted. If such a harvest can be had once in five years this yield would compare favorably with good farm lands of the Middle West. These investigations promise valuable information. Mr. Griffiths has made two trips during the year to parts of Mexico in which the prickly pear is an important crop, securing there many valuable forms of this cactus new to this country. Twelve of these are spineless. Some of them produce edible fruit of good quality. Four plantations for their propagation and study have been established in different parts of the cactus region of this country. The New Mexico Experiment Station, cooperating with the Bureau of Plant Industry, has been making numerous chemical analyses of many species and varieties. The results of these analyses will be published in the near future.

FORAGE CROPS FOR THE GULF COAST REGION.—Prof. S. M. Tracy has continued his investigation of forage crops for the Gulf coast region, giving special attention to the use and value on farms in that section of velvet beans, cassava, beggar weed, and certain new grasses and legumes that give promise of value. A selection of the earliest seed obtainable from the velvet bean was made last autumn. In the spring this seed was distributed in the region just north of that in which this bean is usually grown. Seed will be saved from these plantings this fall for distribution still farther north. While this crop may not supersede the cowpea, it has certain characteristics which render it desirable as an addition to the forage resources of the

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cowpea-growing section. It yields more seed than the cowpea. The seeds are valuable feed, and may be harvested by the stock themselves. After frost strikes the vines, both vine and leaf are greatly relished by all classes of stock, and they are thus valuable as winter pasture.

Of the two main difficulties in the cultivation of cassava, as announced in last year's report, that of securing a good stand of the crop, has been overcome by putting the canes in cold frames and setting out only those that sprout. The difficulty of keeping the canes over winter remains, but apparently a step has been made toward its solution. It was noted last year that one of the newly acquired varieties had produced seed, although set out very late. This Office is now in possession of 23 varieties that produced seed last autumn, all of which was planted this spring, and plants are now growing. Unfortunately, it seems to require two seasons to grow a crop from seed, but one of the seedlings promises to be an annual. It is as large and vigorous at this date (July 1, 1905) as any of those growing from canes.

In cooperation with the Bureau of Chemistry, a chemical study of cassava varieties has been made. These investigations have shown that the prussic acid contained in the roots of all the varieties is found chiefly in the bark of the root. Some varieties contain sufficient of this poison to render them unfit for use in their natural state. The reduction of prussic acid content by selection has been undertaken. We are also investigating the feasibility of drying the roots by simple processes so that they may be cheaply transported and preserved for use as needed.

Considerable attention has been given to Guinea grass and Para grass for Florida and southern Texas during the year. Cuttings of the roots of both of these grasses have been distributed to a number of growers. Our experience with Para grass leads to the belief that it has a large field of usefulness in both of the sections mentioned. It is propagated without difficulty and yields large quantities of forage that is greatly relished by stock. Both of these grasses have become thoroughly established in the vicinity of Tampa, Fla. Another grass which was introduced into Florida some years ago by Professor Tracy, and which is attracting attention because of its large growth and its ease of propagation, is *Tricholæna rosea*, sometimes called Australian redtop and also Hawaiian redtop. It is found in most semitropical countries and possesses considerable forage value. It is of importance because of the small number of available grasses in the regions where it thrives. Seed of it was gathered last season in Florida and distributed to growers for purposes of experiment.

During the season a community in southwestern Georgia has been found in which *Paspalum dilatatum* has become an important hay and pasture grass, and is extensively grown under the name of Dallis grass. Arrangements have been made for securing a considerable quantity of the seed of this grass for experimental purposes.

A bulletin is now in process of preparation giving the results of our study of grasses and forage plants in the Gulf coast region during the past two years.

MEASURING HAY IN THE STACK.—The absence of means of weighing on the farm frequently necessitates the estimation of the weight

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of hay by stack measurements, and many rules have been promulgated for making such estimates. All these rules have been tested and found exceedingly unreliable. Nearly all of them give results much too low, the error being frequently as much as 30 per cent. We have devised a satisfactory formula for determining the cubic contents of a rick of hay, but thus far we are able to give no reliable rule for estimating the number of cubic feet required to make a ton. Our results have varied from 500 to 900 cubic feet. It is clearly established that the height of the rick is an important factor, and our results indicate that this factor can be reduced to rule, although the data at hand are not sufficient to justify the formulation of such a rule. The kind of hay is an important factor; also the length of time the rick has been standing. We have sufficient data on all these factors to indicate that rules may be deduced for all of them. Mr. D. A. Brodie has rendered much valuable assistance in this work during the past season.

EXTERMINATION OF JOHNSON GRASS.—In the last annual report of the work of this Office it was stated that a method of exterminating Johnson grass had been worked out. The essential features of this method are as follows: After cutting the last crop of grass for hay, the land should be broken about 4 inches deep with a 2-horse turning plow, great care being used to cut and turn every inch of the sod. Harrow the land and let it lie till any trash turned under has rotted; then plow again in the same manner as above described. Care should be used to plow the land only when it is moist enough to break up mellow, but not wet enough to puddle. After the second plowing, the rootstocks of the grass are to be removed by means of a root puller (described later). In the spring, plant cotton or any other tilled crop. A few sprigs of grass will come from small pieces of rootstocks left by the root puller. When these sprouts are tall enough they should be pulled by hand, the utmost care being used to pull root and all, as can be easily done because of the mellow condition of the soil. If this work is faithfully done, the grass is completely exterminated. Any Johnson grass coming from seed is easily killed by cultivation.

During the past year our efforts have been directed to devising a practical implement for pulling the rootstocks. The original work was done with an implement manufactured and sold under the name of "grass hoe." It is a small harrow having plow handles attached, a beam with a wheel under the front of it, and long, curved teeth that sink deep into the soil and drag the roots to the surface. The only objection to this implement is its small size and the consequent cost of labor in using it. It is only about 30 inches wide. This objection ought not to be serious on farms that do all their work with one-horse implements, but a larger implement that will do the work effectively is very desirable. During the year two such implements have been devised. The pattern of one of these was suggested by Mr. J. B. Gay, of Columbus, Tex., on whose farm the experiments with Johnson grass have been conducted; the other by Prof. W. J. Spillman, in charge of this Office. The Gay root puller is described in Bulletin No. 72 of the Bureau of Plant Industry, where a complete account of these experiments may be found. The other implement is built on the principle of the ordinary sulky hayrake, the teeth being set in three rows and so arranged as to make tracks 3

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inches apart. Plans are now being made for testing both of these implements on a larger scale and in several localities during the ensuing season.

FORAGE PROBLEMS IN THE PACIFIC NORTHWEST.—The forage-crop investigations on the Pacific coast are conducted by Mr. Byron Hunter, with headquarters at the State experiment station at Pullman, Wash. He reports the following lines of investigation:

Forest burns.—Large areas of the forests of Idaho, Oregon, and Washington are burned over each year. Much of these areas is burned sufficiently to destroy all vegetation, leaving beds of ashes upon which it is comparatively easy to secure a stand of grasses. In order to determine which grasses are best to use in reseeding forest burns and to interest settlers in the matter, seed of a number of the grasses and other forage plants that were thought best adapted to the purpose has been distributed to several farmers in the vicinity of the burned areas. The results of these tests will be reported as soon as they are available.

Introduction of standard forage crops.—In some of the isolated mountain valleys where dairying and stock raising are practically the only occupations of the people, *Vicia villosa*, *V. sativa*, and some of the standard grasses are being introduced to take the place of grain hay.

In the wheat-growing regions of eastern Oregon and eastern Washington alfalfa is rapidly taking the place of wheat for hay. There are many localities where it has not been tried, and we are introducing it into a number of these regions this year. It is our plan to push this same line of work next year where suitable land can be secured—land that has received the proper preparation for the seed bed. Red clover is also being introduced into certain localities where it seems adapted to the conditions.

Testing station at Pullman.—There are more than 400 plats in the grass garden at Pullman at the present time. Last season many forms of the Ceratochloa group of brome grasses were collected. These were planted in the garden this spring to test their comparative value. Forms of *Elymus condensatus*, *Agropyron spicatum*, *A. pseudorepens*, *Dactylis glomerata* (26 varieties), *Phleum pratense* (22 varieties), *Festuca elatior*, *Phalaris arundinacea* (selected with a view of developing a variety that will hold its seed better), several other wild grasses, and several wild vetches were selected and planted in the garden in small plats.

Grasses planted in rows last year yielded so much more than those planted broadcast that it was thought advisable to undertake an experiment to get some data on the comparative yield of row and broadcast cultivation. Experiments for this purpose have been undertaken with *Festuca pratensis*, *F. elatior*, *F. arundinacea*, and alfalfa.

Last year 26 varieties of *Bromus inermis* were secured from the experiment station in eastern Oregon and planted in the garden at Pullman. There is a marked variation in these varieties. The yield of some is several times that of others; some spread more rapidly by the underground stems than others; there is quite a latitude in the dates of heading and blooming. Larger plats of the more

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promising varieties were planted this spring. A large variety of seeds was received from the Offices of Grass and Forage Plant Investigations and of Seed and Plant Introduction and Distribution this spring and planted mostly in rows.

Field investigations.—In the Pacific Northwest the altitude and topography of the country are such that it is divided into many localities differing widely in agricultural conditions. A study of these different localities is being made with a view to securing detailed information regarding the methods of planting, growing, harvesting, and using all classes of grasses and forage crops in each of these natural subdivisions of this section. Sufficient information is already at hand to justify the preparation of short bulletins on alfalfa without irrigation, vetch, rape, and kale, and these will be prepared during the ensuing year.

Cowpeas.—Investigations of cowpeas conducted by Mr. Carleton R. Ball last year were along three lines: (1) Study of varieties; (2) acclimation of early varieties in the Northern States; (3) methods of handling the cowpea crop, especially in the Southern States.

Variety tests were made at the Arlington Experimental Farm, where, owing to the very late, cold, and wet season, the results obtained in a comparative study of all obtainable varieties were very much less conclusive than in previous years. The well-known fact that the cowpea is a plant which is susceptible to great variation in habit through the influence of varying climatic conditions was never better illustrated than during the season of 1904. Only about one-half of more than 100 varieties planted matured seed at all, while the yield of seed of even the standard early varieties was very much reduced. Owing to the prolongation of the vegetative tendency by reason of the season, all varieties produced much longer runners than is normally the case. Even such forms as Warren's Extra Early, Warren's New Hybrid, Whippoorwill, New Era, etc., showed a decided tendency to become trailers.

About 20 varieties obtained from India were grown both on the Arlington Farm and by Mr. S. M. Byrd, of Cedartown, in northwestern Georgia. Only about one-half of them matured seed in either place, the number so maturing at the Arlington Farm being considerably smaller than in Georgia. Only two or three of these indicate any advantage over those already commonly grown in this country, and these are being again grown and studied during the present year in order to determine their qualities under more favorable conditions before accepting them as desirable varieties.

Data giving the habits of the plants, time of maturity, comparative yield, etc., for the past three years are being compiled in anticipation of the completion of the work with varieties.

During the season of 1904, a number of standard varieties of cowpeas were placed at the experiment stations lying north of the latitude of Washington, D. C., so far as the stations were willing to undertake such work. All of the varieties, except possibly those grown at the Nebraska station, were influenced by the same unfavorable conditions which prevailed at Washington, and in the New England States especially an almost complete failure resulted. Encouraging results, however, were reported from the North Central States,

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showing that a number of early varieties were proving valuable as forage and renovating crops in that region.

The same work was continued through the spring of 1905, the number of varieties being increased to more than a dozen, a larger number of stations cooperating. Preliminary reports already received indicate much more favorable conditions so far in the present season.

In the early summer of 1904 seed of the Iron cowpea was distributed in 4-pound lots to between 100 and 150 farmers in the Northern and West Central States, extending as far south as Maryland, Kentucky, Missouri, and Texas. In spite of late planting and the extremely unfavorable season, almost one-half of the reports received from these private cooperators were favorable. Seed was matured in considerable quantities as far north as New Jersey, northern Ohio, and northwestern Nebraska, while smaller amounts were secured in South Dakota and other Northern States. Many of these farmers had never grown any varieties of cowpeas before, and reported themselves as being well pleased with the crop and its possibilities in their agriculture. On the other hand, a considerable number pronounced it a complete failure. In Kansas, Oklahoma, and Texas, where the usual semiarid conditions prevailed, at least during the latter half of the season, there were reported several instances of a considerable degree of drought resistance on the part of this variety. Several cooperators, especially in Texas, stated that it was superior to the Whippoorwill and Blackeye, which they had previously grown. The seed of this variety furnished by the Office of Seed and Plant Introduction and Distribution was grown at Monetta, S. C., not only in a southern latitude but also on a very warm sandy soil. Better results would probably have been obtained had the seed furnished been northern grown. All seed grown in the Northern States in 1904 which could be purchased was secured, and nearly 1,000 pounds of it was distributed this spring at a much earlier date than last year. The distribution took place over much the same territory as the year before, except that the larger proportion of it was sent farther north and the State of Kentucky was omitted, as it lies well within the present cowpea belt.

A small quantity of seed of the Michigan Favorite cowpea was distributed in 1904 in the northern tier of States from the lower New England States to the Dakotas. This variety was said to have been originated by Mr. E. E. Evans, of Westbranch, Ogemaw County, Mich., from whom seed was purchased. Although grown so far north, above latitude 44°, this variety did not show itself much superior to the Iron cowpea when grown by the same individuals under exactly similar conditions. The soil of Ogemaw County seems to be of that warm sandy nature which is very favorable to the development of this plant, so that the high latitude under which it is grown there is not so severe a test as would be a lower latitude with less favorable conditions of soil. This fact doubtless accounts for much of its failure last year. Another distribution of seed has been made this spring, not only in the States lying along the northern boundary of the country, but also in the northern half of the second tier of States from Nebraska to Pennsylvania, inclusive, and it is hoped to acclimate this variety thoroughly over

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this extent of country during the present season. It may be noted that this pea is a member of the Clay group and apparently as nearly related to Warren's Extra Early or Warren's New Hybrid as to any other member of that group.

Considerable information on the culture of the cowpea crop as practiced in the Southern States, and especially in the cotton belt, has already been submitted in a report on a field trip in that section during the autumn of 1904. This information covered the different methods of sowing and handling the cowpea as a catch crop, forage crop, seed crop, and for soil renovation, together with an extended discussion of machinery for picking and thrashing it. A large series of photographs illustrating the subject was secured and is now on file in this Office.

Soy beans.—A varietal study of the soy-bean crop begun in 1903 was continued during the season of 1904 by Mr. Carleton R. Ball. Some 50 or 60 varieties were grown at the Arlington Experimental Farm, as well as by Prof. J. F. Duggar, at Auburn, Ala., and by Messrs. Funk Bros., at Bloomington, Ill. It is much to be regretted that the severe drought prevailing in the lower Mississippi Valley region in the early summer of 1904 should have almost totally destroyed the plantings in Illinois and Alabama. In both cases the crop was destroyed in the tender seedling stage. A second planting of all the varieties was made at Auburn, Ala., after the drought was broken, but proved too late to be of any value in the study of the varieties. On the Arlington Farm the same unfavorable conditions already mentioned made early planting impossible and so prolonged the growing season as to permit only six or eight of the earliest varieties to reach maturity. Owing to the wet, undrained character of the soil, the plants were dwarfed, yellowish, and sickly in appearance throughout the season. Results obtained with a few varieties grown at the different experiment stations have been added to the information previously at hand. A considerable fund of data from the station bulletins, from cooperators, and from the agricultural press has been brought together with a view to bringing up to date our knowledge of the agricultural possibilities of this plant.

All varieties of which seed remained or which it has been possible to obtain since last season have been placed this year for testing at six different points, as follows: Arlington Farm; Knoxville, Tenn.; Baton Rouge, La.; Hays, Kans.; Bloomington, Ill., and St. Anthony Park, Minn.

The number of varieties at each of these places varies from 35 to 40. In addition to these a number of the earlier maturing varieties have been sent to all of the northern experiment stations which were willing to cooperate, so that at the end of the present season a very considerable addition to our present knowledge will undoubtedly be at hand in regard to the value and adaptability of the different standard varieties, as well as the relationships of certain little-known sorts.

Sorghum.—Mr. Carleton R. Ball has continued his study of sorghum varieties. During the present season a very large number of varieties are being grown at a number of different points. Between 300 and 400 so-called varieties have been sent to the Arlington Farm; to San Antonio and Chillicothe, Tex.; Hays, Kans., and Mecca, Cal.

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Smaller numbers, ranging from 30 to 150 varieties, have gone to Miami, Fla.; Knoxville, Tenn.; Baton Rouge, La.; Channing, Tex.; and Rockport, Kans. Careful lookout has been kept for all possible varieties grown in this country. An entirely new and very peculiar form has been discovered in central Texas, where it is grown in a limited way and is considered a very valuable member of this group. From the appearance of the head it should be not only a good yielder of seed but very easily harvested and thrashed. It appears to possess importance as a grain crop.

Careful study of the history of sorghum, with special reference to its source of introduction into this country and the forms that were introduced, has been made. It is estimated that those varieties introduced and those originated in this country already exceed 200 in number. The place and method of origin of a number of more important varieties have been traced, and the identity of the well-known and important sumac or redtop sorghum of the Southern States has been quite clearly established with one of the original importations from South Africa, in 1857.

Over 1,000 cards bearing on the history, botany, geography, and culture of sorghum varieties have been prepared, and the work is being continued. A revision of Farmers' Bulletin No. 50, entitled "Sorghum as a Forage Crop," has been almost completed, while data are already in hand for a more technical publication on the saccharine and nonsaccharine varieties of the United States.

LAWNS.—The investigations on the subject of lawns and lawn management conducted by Mr. Carleton R. Ball included last year experiments in the destruction of crab-grass, the seeding of shaded areas, and the determination of the best time for seeding various lawn grasses.

Destruction of crab-grass and other weeds.—Experiments were made to determine the possibility of destroying crab-grass which has become established in good grass sward without injury to the bluegrass. Solutions of different strength of sodium arsenate and carbolic acid were used, but the weakest solution which was even partially effective in destroying the crab-grass was equally destructive to the bluegrass, and the only conclusion that can be reached is that with these two chemicals, at least, it will not be practicable to destroy crab-grass in a lawn sward.

It was demonstrated, however, that by the skillful use of an iron rake it is possible to lift into a semierect position the prostrate and creeping seed stems which are abundantly developed on the crab-grass under the depressing influence of the lawn mower. Thus lifted up, these seed stems may be cut off by running the lawn mower at right angles or in the opposite direction to that in which the rake has been used, and the production of seed on even a very thick sward of crab-grass can be almost entirely prevented. At the same time its smothering effect upon the lawn sward in which it grows is very materially lessened.

Seeding of shaded areas.—Experiments made in sowing different grasses in shaded areas seem to indicate that where a good quality of seed of the rough-stalked meadow grass (*Poa trivialis*) can be secured it is the most satisfactory species for growth in heavy shade

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where Kentucky bluegrass does not thrive. Kentucky bluegrass withstands the effect of shading to a considerable degree, especially in low-lying soils of the middle and south Atlantic coast, where it does not make a satisfactory growth in the open. As far south as Raleigh, N. C., at an elevation of little more than 200 feet, Kentucky bluegrass is found abundantly in well-shaded lawns, except in the open parts, in which its place has been gradually taken by Bermuda grass and weeds. It has been determined also that redtop and creeping bent grass will each thrive under conditions of some shade, but perhaps not to as great an extent as Kentucky bluegrass. They are, however, much better adapted to the low-lying lands and to the moist and perhaps somewhat acid soil of the middle and northern Atlantic coast region.

Time of seeding.—Plats of Kentucky bluegrass, redtop, creeping bent, and meadow foxtail sown at intervals from early spring until the middle of August show that it is possible to secure a good stand and very satisfactory and permanent growth of these grasses, even when sown in midsummer, provided they are given proper attention in the matter of seed bed and subsequent watering.

HERBARIUM WORK.—The systematic study of the North American grasses has been carried on under the direction of Prof. C. V. Piper, Systematic Agrostologist, assisted by Mr. P. L. Ricker. As far as the press of purely economic work would allow, other members of the staff have assisted, each working on a special group. The aim has been primarily to prepare monographs of the more important grass genera, especially such as are of great economic importance. It is recognized that this work is in the main a purely scientific contribution on the part of the Office, and arrangements have been made for transferring this work to the Office of the Botanist. The necessity for accurate knowledge concerning the grass species with which this Office has to deal, especially in connection with its range work and the domestication of some of the more important native grasses, has heretofore made it necessary for this Office to carry on investigations of this kind.

During the past year there has been published as Bulletin No. 68 of the Bureau of Plant Industry a monograph of the North American species of Agrostis. This is the result of several years' continuous study of the genus by Prof. A. S. Hitchcock, and it clears up very satisfactorily one of the most puzzling, as well as important, genera of our grasses. There is also in manuscript a completed monograph of the genus Festuca, by Professor Piper. This will be published at an early date in the Contributions from the United States National Herbarium. In addition to these published results, considerable progress toward completion has been made on the genus Bouteloua, by Dr. David Griffiths; on Oryzopsis and Stipa, by Mr. Ricker; on Poa, by Professor Piper, and on Panicum, by Professor Hitchcock and Mrs. Agnes Chase. There is also in manuscript a monograph of the genus Paspalum, by Mr. G. V. Nash, which it is hoped may shortly be published. In addition to these more important studies, various brief papers dealing with grasses in a systematic way have been published by Professors Piper and Hitchcock.

Apart from the above studies, which are primarily technical in nature, a systematic search has been made through the herbarium in order to detect grasses not already in cultivation which, from the

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appearance of the specimens and herbarium notes, give promise of being valuable under cultivation. A considerable list of these has been made, and it is hoped that it will be possible to secure seed of many of them in order to test their economic value.

Mr. Ricker has devoted much of his time to two pieces of bibliographic work which it is essential should be completed before we are in position to do really valuable systematic work upon the North American grasses. The first of these is a critical study of the types of all the genera of grasses. It is found that a large number of names are in use for grasses which were used many years earlier for other groups of plants, and also, in a smaller number of cases, that the species commonly referred to certain genera are not congeneric with the type of the genus or of the species originally described. Up to the present time it has been impossible to verify all of the original publications of the grass genera and thus determine exactly what their types are, as many of the works needed are not available in Washington.

The second piece of bibliographic work is a list of all species of grasses which have been described from or credited to North America, and it is hoped to give data regarding the location and the identification of the types of the larger part of these species. A list of several hundred species published by Steudel as having been originally collected in this country has been made. A large number of these species are absolutely unknown at the present time, and it is probable in many cases that they are now designated by different names. As most of the types in this list are located in the herbarium of the University of Oxford, Professor Vines, of that institution, has been kind enough to offer to lend such of these species as we may desire, provided they can come to us through the United States embassy at London. Arrangements are being made for the receipt of these specimens, which will do much toward clearing up many of the names which we have been unable to associate with any definite species.

For the immediate future it is proposed to spend considerable time in the completion of the two above-mentioned pieces of bibliographic work.

Soil and sand binders.—Work has been continued by Mr. J. M. Westgate upon the problem of reclaiming the shifting sand dunes along the coasts of the Atlantic and Pacific oceans and of Lake Michigan and in the valley of the Columbia River.

The work at The Dalles, Oreg., has been done in cooperation with the Oregon Railroad and Navigation Company and the Great Southern Railroad Company. The problem of establishing vegetation upon the dunes is rendered difficult by the small size of the sand grains, causing them to shift rapidly with the almost constant westerly winds. The dunes shift as much as 100 feet during the summer season, which is practically without rainfall. The working plan which is being carried out involves the establishment of vegetation upon the dunes which are already some distance inland from the river. A new departure from the methods hitherto undertaken consists in accumulating near the water's edge the sand which is cast up as the river recedes after floods. The sand fences devised for this purpose have proved efficient in holding this sand below the normal

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high-water mark until it is carried down by the succeeding spring freshets. In this way the supply of sand is cut off, and the problem of controlling the sand already blown inland is simplified, as the annual increments of sand from the river have made its control difficult.

At Saugatuck, Mich., a working plan has been developed and put into operation upon a dune 240 feet high, which threatens to destroy the harbor at that place. The plan calls for the gradual filling in with sand blown up from the lake of the large blow-out on the lake side of the dune. The vegetation will be introduced in successive stages as fast as the necessary sand accumulations are made by the fences now in operation. The first section has already been covered with plantings of *Ammophila arenaria* and *Calamovilfa longifolia*, in connection with other sand-binding vegetation, which gives promise of success.

At Manistee, Mich., the problem has been practically solved, and the 14 acres of shifting dunes no longer threaten the city with burial. *Elymus canadensis* and *Ammophila arenaria*, in connection with brush lines, have proved efficient protection to the woody vegetation which is now established.

Experiments are being inaugurated at Fortress Monroe, Va., to determine the most suitable covering for the sand areas adjoining the fortifications.

Investigations are being continued in connection with soil binders, especially those adapted for railway cuts and embankments. It has been found necessary to reduce the slope and to provide some system of drainage before sodding or introducing sets of Japanese honeysuckle or grasses.

CROPS FOR OVERFLOWED LANDS.—Experiments have been continued at Pekin, Ill., to determine the most suitable crops for the lands that are subject to prolonged periods of inundation. The overflow has been found to be too prolonged for the successful growth of any perennial grass upon the lower portions of the areas under observation. *Beckmannia eruciformis* and *Phalaris arundinacea* have been found to survive upon those areas subject to not more than two months of overflow. *Agrostis vulgaris* has proved best adapted to the higher portions of the areas where the inundation lasts for only a few weeks. The possibilities with quickly maturing annual forage plants have been determined. The utilization of the lands for this purpose appears to be the most practical solution of the problem. Such crops as millet, sorghum, rape, and corn sown for forage, with buckwheat as a possibility for a grain crop, have given the best results.

OFFICE WORK.—The increase in correspondence of the Office, consisting largely of calls for information, denotes increased recognition on the part of the farming public of the work of the Department relating to grasses and forage plants. In previous annual reports attention has been called to the enormous correspondence relating to alfalfa. Interest in this plant is even greater at the present time than it was last year. Much of the time of the scientific staff has necessarily been devoted during the past year to consultation with the increasing number of farmers who visit the Office in quest of information. An attempt has been made to meet the most insistent

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demands for information by means of publications, and considerable progress in this direction has been made during the year.

FUTURE WORK.—Most of the lines of work outlined will be continued. A few of these branches have been transferred to other offices to enable this Office to devote more of its energy to the study of farm practice and a systematic effort to assist farmers in improving their methods. The systematic work, including the extensive herbarium belonging to the Office, has been transferred to the Office of the Botanist of this Bureau. Investigations relating to the introduction and distribution of grasses and forage plants will hereafter be conducted, in the main, by the Office of Seed and Plant Introduction and Distribution.

In our range investigations experiments on the reseeding of ranges will be continued in Washington, California, and Arizona. In all of these localities we are cooperating with a number of ranchmen, to whom information is furnished concerning the best grasses to sow and methods of establishing these grasses on the ranges. Pasture experiments on the large fenced area in Arizona are contemplated during the coming year. This area has become regrassed during the two years it has been protected from stock, and we desire to determine its carrying capacity—that is, the amount of stock it will support without deterioration in the character of the range. We have arranged with many stockmen throughout the range country to keep careful records of the number of stock upon their ranges and the season of the year at which each portion of the range is utilized. These records will furnish much valuable information concerning the carrying capacity of the ranges in different parts of the country. We shall continue the careful study of the systems of management in vogue on large range tracts owned by private persons who are in position to control stock upon them. Information will also be gathered concerning the distribution of stock on the ranges. We are in correspondence with county officials all over the range country with a view to securing data on this point.

In our investigations on the cactus plant particular attention will be given to the habits of growth of various species and varieties, methods of propagation, yield, rate of growth, and adaptability to climatic and soil conditions. We shall continue our cooperative work with the New Mexico Experiment Station. The officials of that station will make chemical food analyses of many varieties, and it is hoped they will be able to conduct a digestion experiment with some of the most important varieties.

The possibility of growing cassava from seed will be fully exploited. Further study will be given to the prussic-acid content of the different varieties, and the attempt will be made to secure nonpoisonous varieties of high yielding power. Experiments on methods of keeping cassava canes over winter will be continued.

Extensive experiments with Para and Guinea grasses have been planned with a view to ascertaining the northern limit of the cultivation of these grasses, best methods of propagation, yield, and forage value.

In the Pacific Northwest extensive studies of the vetches will be made. This group of legumes has had a higher development in that section than in any other part of the United States. It is hoped that

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we shall be in position to publish a bulletin on the vetches in western Oregon and western Washington during the coming year.

We shall continue our efforts to extend alfalfa culture on the wheat lands east of the Cascade Mountains, as well as to extend the cultivation of corn for fodder and silage on summer fallow.

Particular attention will be given to the relation of the various grasses and forage plants found in the Pacific Northwest to climatic and soil conditions. We shall also study the practice of farmers concerning the planting, growing, and utilization of the crops.

In cooperation with the Tennessee State Experiment Station we have arranged for a plat demonstration of the relation of the consumption of forage plants to the building up of soil fertility. One set of plats will be farmed in such manner as to remove all crops from the soil and return nothing. No legumes will be grown. Another set of plats will be farmed in a similar manner, but one or more of the crops in the rotation will be legumes. Another type of farming illustrated in this demonstration will be one in which half of the crops are fed and the manure returned to the land. This demonstration will include rotations with and without legumes. A third type of farming illustrated will be that in which all the crops are fed, the manure being returned to the land. A fourth type will be devoted to the production of hay, silage, and other roughage, all of which will be fed and sufficient grain added to balance the ration properly, all the manure thus produced being returned to the land.

The rotation experiment which has been in progress in cooperation with the Kentucky Experiment Station will be continued; likewise the experiment for the production of beef cattle in connection with the Missouri Experiment Station.

In connection with the Johnson grass investigations of this Office, plans have been matured for demonstrations in several localities of the methods worked out in the experiments previously conducted.

POMOLOGICAL INVESTIGATIONS.

The work of the Office of Pomological Investigations is under the supervision of Col. G. B. Brackett, Pomologist. As in former years, since 1901, the Pomological Field Investigations have been conducted under the direction of Mr. William A. Taylor, pomologist in charge. The more important of these are grouped under the five following heads: (1) Fruit Marketing; (2) Fruit Storage; (3) Viticultural Investigations; (4) Fruit District Investigations; (5) Miscellaneous Field Problems.

FRUIT MARKETING.

Studies of methods of harvesting, packing, and forwarding orchard fruits have been made under the joint direction of the pomologist in charge and Mr. G. Harold Powell, assisted during a portion of the year by Messrs. S. H. Fulton, assistant pomologist, and Guy L. Stewart, special agent. This work is closely associated with the fruit-storage work in many particulars, certain lots of fruit being frequently utilized for experiments in both lines. Though not entirely restricted to fruits for export, in the fruit-marketing work attention has been chiefly paid to problems connected with the forwarding of American fruits to foreign countries, with special refer-

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ence to the development of a healthy export demand for American fruit.

From the beginning it has been recognized that the most important point connected with the development of export trade in perishable fruits is the ability to deliver an attractive and desirable product to the foreign consumer in sound and wholesome condition at a season when the product is in demand. With the more durable fruits, such as winter apples and pears, destined for European markets, this is theoretically not difficult. But experience has repeatedly demonstrated that even in the case of these fruits a considerable proportion of fruit forwarded from the United States and Canada reaches European markets in bad condition, or in some other particular falls short of the demands of foreign consumers. In some instances this is the outgrowth of faulty methods of harvesting, grading, and packing; in others, the fruit, though originally of good quality and well packed, is held too long before shipment, or forwarded by ordinary freight cars to the seaboard and thence in common stowage, instead of in refrigerated compartments at a uniform temperature. In other cases varieties otherwise desirable are consigned to markets where they are not in demand.

All of these causes are more or less constantly in operation and serve to check that development of export trade which should occur under the existing conditions of supply and demand. While the losses experienced in such cases fall primarily upon individual shippers, their ultimate effect is to lower the reputation and diminish the value of all American fresh fruits in those markets. In these investigations, therefore, there has been constant effort (1) to determine the exact present status of the export trade in each important fruit, and (2) to devise methods of insuring the delivery of the product in better condition, and, where the outlook is promising, to introduce such fruits to markets that have not previously taken them in commercial quantities.

The fruit season of 1904–5 was in many respects unusual, especially as regards the apple and pear crops, which fruits constitute the most important items in the trans-Atlantic fresh fruit export trade. While the crop of these in the United States and Canada, taken as a whole, was not overabundant (in fact, was probably not larger than the average for the preceding five years), the European crops were very heavy, especially those of Great Britain and France. The principal European markets were consequently oversupplied with homegrown apples and pears at low prices during the summer, autumn, and early winter, greatly reducing the demand for the American product. This was especially noticeable during the autumn and early winter, when, in normal seasons, the export demand for American and Canadian apples is very heavy. While official statistics of exports are not yet available, commercial estimates of the trans-Atlantic movement of apples show a falling off during the season of 1904–5 of 1,093,711 barrels, the total quantity exported being 30 per cent less than the record season of 1903–4. It is worthy of note in this connection that by far the larger part of the decrease is accounted for by the falling off in shipments made prior to January 1, 1905, the shipments after that date having been but 17 per cent, or 172,667 bar-

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rels, less than during the corresponding period of the previous year. The percentage of the total shipments furnished by the United States was considerably higher than in the previous year, and was equal to the highest attained during the last five years.

The lack of export demand during the early part of the season was undoubtedly responsible for the low prices that prevailed in American markets until late in the winter. It demonstrates most emphatically the importance to our apple growers of an export outlet ample to care for any surplus that is likely to occur from year to year, inasmuch as the farm value of the entire crop is greatly reduced by the existence of any considerable surplus. The beneficial influence of adequate cold-storage capacity was very marked during the season just passed, as it permitted the holding back of a considerable quantity of fruit which would otherwise have served to depress values still further. It also accounts for the heavier export shipments late in the season, for some of which very high prices were obtained and most of which proved fairly remunerative.

Experimental export shipments of summer apples in July and early August from Delaware to London, in continuation of work previously inaugurated, developed the fact that in the face of a full crop of summer fruits in Europe only the very choicest American varieties of this character can be exported with profit. In seasons of normal or short yield in Europe there appears no reason to question the practicability of profitable export prices along this line.

Comparative export shipments of eastern-grown winter apples in barrels and boxes, so distributed as to cover the shipping season from early winter until late spring, were made to the principal European markets. In these special attention was given to contrasting graded and ungraded fruit. While the work has not yet progressed far enough to warrant the formulation of general conclusions, the general averages, contrary to previous experience, appear to show greater profit resulting from shipment in boxes than in barrels, with both graded and ungraded fruit. The Hamburg market, in particular, shows an inclination to pay well for the boxing and wrapping of the fruit. This market also proved a very desirable one for russet apples, shipments to it during the season yielding much higher net returns than were obtained from the overloaded Paris market on similar fruit.

Exports of pears were light, largely through the same causes that influenced apple shipments. The practicability of the profitable exportation of this fruit when the market conditions are favorable has been thoroughly demonstrated, however, and a considerable development along this line is likely to occur in the near future.

Experimental export shipments of peaches, chiefly from Georgia, were made along lines previously followed. These have demonstrated the feasibility of delivering the fruit in sound condition and obtaining remunerative prices for it when the weather at the harvest time is favorable to good carrying quality of the fruit. The importance of facilities for the quick cooling of such fruit after removal from the tree can hardly be overestimated, however, and in view of the variable conditions of heat and humidity experienced in the Eastern and Southern States during the peach harvest such facilities will perhaps be essential to the development of regularly profitable export

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business. It is hoped that facilities sufficient for a thorough test along this line will become available during the ensuing fiscal year.

Contemplated export shipments of Florida-grown pomelos were prevented by an untimely freeze, which largely reduced the supply of available fruit.

An experimental shipment of avocados from Hawaii, made in cooperation with the Hawaii Experiment Station, utilizing commercial facilities kindly made available by one of the leading shippers in the California fruit trade, demonstrated the possibility of delivering this delicate and perishable fruit in the New York market in sound condition late in the season at a time when it is in demand there at good prices. While it is not anticipated that any large development along this line is likely to result, it is believed that with proper encouragement a considerable production of fruit of this character in Hawaii will find good markets in the cities of our own Pacific coast.

FRUIT STORAGE.

The fruit-storage investigations have been conducted, as heretofore, under the direction of Mr. G. Harold Powell, pomologist in charge, assisted by Mr. S. H. Fulton, assistant pomologist. From July 1, 1904, until February 15, 1905, Mr. Guy L. Stewart was also associated with Mr. Powell in this work, and upon his resignation, which took effect on the latter date, Mr. Lloyd S. Tenny, assistant pathologist, was detailed to assist in the citrus-fruit investigations in southern California, which were then in progress. The fruit-storage investigations have been continued along lines indicated in the last annual report, and have been extended in such directions as seemed necessary. Considerable quantities of apples grown in different soils, on trees of different ages, in orchards in sod and in tillage, including fruit of different sizes from the same trees, have been stored in cold-storage warehouses in Buffalo, N. Y., Jersey City, N. J., and Washington, D. C. The fruit has been handled in different ways, both before and after storing, to bring out clearly the effect of present commercial methods of handling the apple upon its behavior in storage. As in former years, the fruit has been picked at different stages of maturity; it has been stored after various lapses of time between picking and storing, and the treatment has been varied in other ways.

This line of investigation has now covered four seasons, and it is believed that sufficient data have been secured to base safe general recommendations for governing the successful handling in storage of the types of apples that are most largely grown east of the Rocky Mountains for storage purposes. Several phases of this work may, therefore, now be discontinued so far as they relate to these eastern apple districts. No storage investigation has yet been made of the fruit grown in the Rocky Mountain and Pacific coast districts.

The experiments during four years have shown conclusively that a large proportion of the difficulties in apple storage may be overcome by more rational handling of the fruit before it is stored, and by giving it better care in some respects after it reaches the storage house. Apple scald, one of the most serious storage troubles, is not yet well understood, but the experiments have again demonstrated that it can be controlled commercially by picking the apples when hard-ripe

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instead of prematurely, as many winter apples are picked, and by storing them quickly after picking in a temperature of about 31° F., or by selling the more susceptible varieties comparatively early in the season. The premature ripening of apples in storage is often the result of delaying the storage too long after the fruit is picked. These investigations continue to emphasize the supreme importance of quick storage after the fruit leaves the tree. The "slumping" of apples in the barrels, due to the development of the common blue-mold fungi in the spring, is generally the direct result of the rough handling of the fruit while it is being picked and packed. The skin of the fruit is bruised, and the rots enter and grow vigorously if the fruit is not stored in a cold temperature soon after picking.

The investigations continue to emphasize the need of a uniform temperature as low as 31° to 32° F. for long-term storage, and of pure, wholesome air in the warehouse if the flavor of the fruit is to be retained without contamination. Cold-stored fruits are frequently injured in quality through the lack of proper ventilation of the storage warehouse. This side of the storage question needs further investigation, which can not be satisfactorily made until the Department has an experimental storage plant.

These investigations continue to show that the conditions under which the fruit is grown exert a marked influence on its keeping quality, often causing the storage season of a variety to vary several months when fruit grown on trees of different ages, in different soils, or under other varying conditions, is contrasted. Any condition that causes the fruit to grow with unusual rapidity appears to shorten its storage life. Experiments upon an important phase of this work are in progress with the New York State Experiment Station, which is investigating the influence of various methods of apple-orchard handling upon the productiveness and vigor of the trees and the character of the fruit. The Department is undertaking, with the station, to determine how these orchard methods influence the keeping quality of the fruit. This phase of the work will have to be continued several years to accomplish satisfactory results.

Another branch of the work is a comparison of the storage quality of different varieties of apples. This work has continued during four seasons, and will now be discontinued in so far as it relates to apples grown in the Eastern States. More than 170 varieties have been under observation in this connection during the past year. Besides securing fruit from many commercial orchards for this purpose, the officers of the experiment stations in Michigan, Maine, Massachusetts, Virginia, and of the New York State Experiment Station turned over to the Department a large number of varieties from their collections for these tests. A test of unwrapped fruit in contrast with identical fruit wrapped in different kinds of fruit wraps will be concluded this year.

A new phase of storage work was undertaken during the past year to determine what systems of cold storage are most likely to succeed under fruit-farm conditions. The farm fruit-storage house is likely to be an important factor in the future handling of the apple crop, and there is a widespread interest in determining the practicability and efficiency of such houses. Apples of like character handled under similar conditions have been stored in a common (uncooled) storage

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house at Ghent, N. Y., and in farm cold-storage houses cooled with ice, ice and salt, brine cooled with ice and salt, and mechanical refrigeration at Old Chatham, Stuyvesant Falls, Newburgh, and Poughkeepsie, N. Y. While at least another year of investigation will be required before it is safe to draw general conclusions from this investigation, the practicability of the small farm storage house can not be questioned, provided it is well built and so equipped that the fruit can be quickly cooled down during the warm weather that is likely to occur during and for some time after the picking season. In the Hudson River Valley, where the plants tested are located, apples kept in the farm storage houses were in practically as good condition up to the end of March as fruit of the same varieties from the same orchards stored in a large, modern, city cold-storage house. In this connection it should be stated that the autumn of 1904 in that region was cool and favorable to the keeping quality of winter apples. Whether these houses would be equally efficient in a warm and unfavorable autumn is yet to be determined.

Investigation of the storage behavior of small fruits has been continued at Washington. It has been found that all the small fruits tested can be kept in best condition if protected from direct contact with the air in the cold-storage room. This may be accomplished by wrapping the entire crate with heavy paper, by wrapping each basket in thin, impervious paper, such as japanin or paraffin paper, or by placing the fruit in small sealed cardboard or paper packages. By employing any one of these methods the deterioration of flavor due to tainting by foul air in storage rooms may be prevented, and the growth of mold seems to be considerably restricted. Under the most favorable conditions the storage of small fruits is a critical business. They may safely be stored for a short time only.

Investigations of the practicability of freezing small fruits for use by bakers, restaurateurs, and confectioners have been made, the results of which appear to indicate that for use in ice cream, sherbets, etc., and for pies, frozen fruit is nearly equal to that in the fresh state. Such quickly perishable fruits as raspberries, blackberries, and huckleberries, for example, can be held in ordinary storage only for a few days, but by freezing quickly in the storage room can be held in very good condition for several weeks, or even months, as in the case of huckleberries. This new phase of the cold-storage business is already having a considerable influence upon the small-fruit market in our large cities.

During the past year an investigation of the causes of the decay and softening of perishable fruits, like the peach, during transportation to market was begun. It has been discovered that a large part of the difficulty is due to bad handling or improper condition of the fruit before it is placed in the refrigerator car. Through the cooperation of the Hale Georgia Orchard Company at Fort Valley, Ga., a number of carloads of peaches were forwarded to northern markets and an accurate record of the condition of the fruit in different parts of the cars was made. The fruit was packed in the 6-basket carriers commonly used for peaches in that State, the carriers being loaded five tiers high in the refrigerator cars in the usual way. It was found that under the conditions experienced at

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Fort Valley the fruit often has a temperature of 90° to 95° F. when loaded. Under present practice the ice in the refrigerator car is expected to do the initial cooling as well as to maintain the desired low temperature afterwards. Early, tender-fleshed varieties, like Carman and Waddell, and firmer kinds, like Belle, Thurber, and Elberta, were included in these tests. The early, tender-fleshed varieties often showed from 5 to 20 per cent of soft and decayed fruit in the two upper tiers of carriers in the car, while the three bottom tiers arrived in the northern markets in sound condition. This unequal condition on arrival is unquestionably due to the more rapid cooling of the fruit in the bottom of the car, and emphasizes the conclusion previously reached in these investigations, that quick cooling after picking is a fundamental requirement in successful cold-storage operations. To test the accuracy of this point, a temporary cooling plant, consisting of two refrigerator cars, was devised in an orchard of the Hale Company. In each of these half a carload of fruit was placed for cooling prior to loading in cars for shipment. These coolers were refrigerated by using ice and salt in their ice bunkers, the temperature of the fruit being in this way reduced to about 40° F. in about twenty-four hours. Fruit loaded at the same time into refrigerator cars with ordinary icing and reicing did not reach a temperature of 40° to 50° F. within three to five days. After the fruit in the coolers had reached a temperature of about 40° F., it was transferred to a refrigerator car and sent North under regular icing. Nine carloads of peaches, or about 6,000 packages, were forwarded under these conditions, with the result that practically all of the fruit arrived in New York and other Northern markets in sound condition, with no loss even in the upper tiers of carriers. Recording thermometers showed that under these conditions the ordinary icing of the car maintained in transit the low initial temperature of the fruit. Peaches handled in this way can be left on the trees until much riper, and therefore until they possess finer flavor and higher color than is possible with ordinary shipments, and still will arrive at destination in perfectly sound condition. After removal from the car, such fruit remains sound longer than the prematurely picked fruit shipped under ordinary icing.

This investigation opens a large field for future work, as it is believed that it may be the means of improving the handling of all kinds of plant products that are shipped in refrigeration. In this connection it should be stated that the work in Georgia was accomplished through the cooperation of the transportation and refrigerator-car companies.

With a view to ascertaining whether the precooling of peaches intended for express shipment in ordinary cars without refrigeration would materially increase the durability of fruit thus handled, tests of this method were made on a comparatively small scale at Winchester, Va. While the quantity of fruit used for these tests does not warrant the drawing of general conclusions therefrom, the tests appear to show that the precooled fruit reached market in firmer and sounder condition than that shipped direct from the trees in the same way. In these tests the fruit was cooled in a storage room in an artificial ice plant, and after its temperature was reduced to about 40° F. it was forwarded in the usual way by express

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without ice. Where a storage house affording suitable facilities is available, this method makes it possible for the grower to hold back his fruit temporarily in times of glut and to ship after the market has revived, a point which is frequently of much importance with express shipments. It was found that in a storage room having a temperature of 35° to 40° F. about twenty-four hours was required to reduce the fruit temperature to approximately 40° F.

For several years the citrus-fruit interests of California have urged the Department to undertake a study of the causes of the decay in oranges and lemons in transit from that State to eastern markets. The citrus industry there has grown up chiefly during the past twenty-five years, and has attained large importance, the shipments during the present year being approximately 30,000 carloads. The losses from decay in transit are said to aggregate not less than half a million dollars a year. The decay is caused principally by blue-mold fungi, which usually gain entrance to the fruit through some abrasion of the skin. Although the appropriation available for investigating this subject was very small, the urgency of the work was recognized, and an investigation was begun about January 1, 1905. Through the fullest and most hearty cooperation of growers, packers, marketing associations, transportation companies, and warehousemen, a fairly comprehensive view of the situation has been obtained, and certain fundamental points in the handling of oranges have been determined.

Through systematic observation of the actual practice of growers and packers in the handling of oranges, it was discovered that on the average about one-fifth of the orange crop is made susceptible to decay by improper handling before the fruit is packed. This condition is brought about by the puncturing of the skin with the clippers used in cutting the oranges from the trees; by punctures from stems left too long; by finger-nail cuts; and by other mechanical injuries in the handling of fruit in the orchards and packing houses. The molds gain entrance through these abrasions. A wide difference was found in the amount of injury caused by different pickers, and in the fruit of different growers when taken as a whole, the variations in these particulars sometimes ranging from 5 to 80 per cent. All of this injured fruit, of course, does not rot—only that in which mold spores are present and which is surrounded by warm, moist air. Comparative experiments in the packing houses demonstrated that from 10 to 50 per cent of this mechanically injured fruit might decay under conditions favorable to the development of the mold, while oranges that were physically perfect seldom showed decay under similar conditions. A preliminary study of the method of brushing the fruit in the packing houses indicates that brushed fruit is more likely to decay, probably because the brush is an efficient means of inoculating the bruised fruit. A careful study of packing-house methods has not been completed.

During the orange shipping season, about 35 cars of oranges were forwarded in which at least a part of the fruit in each car was handled under uniform experimental conditions, the fruit being packed under the direction of the Bureau's representatives in California and inspected by other agents of the Department in the eastern markets. As a result, it was found that oranges picked and care-

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fully handled so as to eliminate mechanical injuries nearly always arrived in the East in good condition, while fruit that was injured before packing would develop from 5 to 25 per cent of decay in the same carloads. A study of the distribution of decay in the car, based on careful inspection of 12 carloads of fruit, showed that 62 per cent of the decay occurred in the upper one of the two tiers of boxes in the cars. In an orange box the decay was found to be most prevalent in the center of the package where the fruit receives least ventilation and is cooled most slowly, the ventilation of oranges as packed in boxes for shipment being quite imperfect at best, on account of the bulk of the fruit in the package.

In a test of the effect of cooling oranges before shipment, to determine whether decay could be prevented by this treatment, 19 carloads of fruit were cooled to a temperature of about 40° F. at Los Angeles, Cal., before being shipped under ordinary icing. The shipping season was too cool for the best results anticipated for this method of handling, the fruit seldom being above 62° to 65° F. when packed. All of the cars arrived in as good condition as those containing fruit under ordinary icing, and most of them in better condition. Practically all of the usual difference in the condition of the fruit in the bottom and top of the car was eliminated by this method. The precooling of fruit for long shipment is in line with the common practice in the handling of meats, in which the temperature of the meat is reduced to the desired point before it is loaded in the car for transit.

These preliminary investigations in the handling of citrus fruits awakened a lively interest throughout the citrus belt. Many evidences are at hand that the growers and packers are already adopting the suggestions worked out by the Department. Prominent orange growers in southern California have estimated that the timely beginning of this investigation and the prompt adoption of reforms in handling and packing the fruit suggested by the Department saved the citrus industry of southern California at least $200,000 during the season just closed. These investigations will need to be continued several years before general conclusions can be drawn from them.

The conditions under which the fruit is grown, such as the location, the soil, the care of the grove, and the age of the trees, must exert an important influence on its shipping quality. This phase of the industry is under investigation by the University of California, with which the Department is cooperating along these lines.

In addition to the lines of work above outlined, certain investigations of the behavior of fruits in cold storage are progressing in cooperation with the Bureau of Chemistry and with the Pathologist and Physiologist of the Bureau of Plant Industry.

VITICULTURAL INVESTIGATIONS.

The grape investigations have been continued under the personal direction of Mr. George C. Husmann, viticulturist in charge, who has been assisted in the work on the Pacific coast by Mr. G. H. Hecke, expert in viticulture. Data collected by observation and through various reliable channels emphasize the importance and urgency of the investigations already under way and of certain additional prob-

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lems which should be taken up in the near future. In California large new plantings are being made to replace the vineyards that have been gradually destroyed by phylloxera, vine diseases, and other agencies, so that it is of the utmost importance to the future of the industry that the relative adaptability of resistant stocks to soils and the congeniality of the Vinifera varieties to resistant stocks be worked out at the earliest possible date. For lack of information on these points many of the vineyards are now being planted with nonresistant varieties, which will almost certainly succumb to the same causes that have resulted in the destruction of at least 100,000 acres of vineyards in California during recent years.

Including the lines of viticultural investigations mentioned in former reports, the following problems are now under investigation:

(1) A comprehensive test of resistant varieties of vines to determine their adaptability to the different vineyard soils and climatic conditions of the Pacific slope.

(2) The determination of the congeniality of the leading Vinifera varieties to the leading resistant stocks.

(3) The determination of the relative adaptability of fruiting varieties of grapes to the important vineyard districts.

(4) A comprehensive test of "direct producers"—that is, such varieties as yield desirable fruit and are at the same time resistant to phylloxera and other enemies.

(5) The determination of the relative adaptability of grape varieties to desert conditions.

(6) The determination of the relative rooting qualities of the resistant-stock varieties as affecting their commercial value as graft bearers.

(7) A comprehensive study of all classes of grapes with reference to their resistance to diseases, for the purpose of improving their vigor, productiveness, and other important characteristics through proper methods of propagation.

In the nine experimental vineyards in California, as outlined in the report of last year, additional plantings have been made, so that they now comprise the following: Oakville, Napa County (10 acres), 200 resistant varieties and 53 Vinifera varieties grafted on resistant stocks; Fresno, Fresno County (6 acres), 164 resistant varieties and 53 Vinifera varieties grafted on resistant stocks; Cucamonga, San Bernardino County (8 acres), 58 resistant varieties and 280 Vinifera varieties on own roots; Mountainview, Santa Clara County (1½ acres), 100 resistant varieties; Sonoma, Sonoma County (1$\frac{1}{10}$ acres), 97 resistant varieties; Livermore, Alameda County (1 acre), 87 resistant varieties; Lodi, San Joaquin County (1⅜ acres), 84 resistant varieties; Geyserville, Sonoma County (1 acre), 83 resistant varieties.

At the Oakville experimental vineyard there were grafted in the spring of 1905 on Lenoir and Rupestris St. George stocks 106 Vinifera varieties, besides the 20 leading red and white wine varieties grafted on Lenoir, Herbemont, Rupestris St. George, Rupestris Martin, Champini, and Doaniana.

At the Fresno vineyard 43 Vinifera varieties (mostly table and raisin grapes) were grafted on Lenoir and Rupestris St. George, besides the 10 leading raisin and wine grape varieties grown in that

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section, not included in the collection at Oakville, which were grafted on Lenoir, Herbemont, Rupestris St. George, Rupestris Martin, Riparia Gloire, Doaniana, and Champini stocks. While it is, of course, too soon to expect accurate results from this work, some very interesting differences in the behavior of grafts, throwing light upon the probable congeniality of varieties to stock, have been observed.

It should be noted that the 58 resistant varieties planted at Cucamonga in the spring of 1905 have been included in that collection, which has hitherto consisted entirely of Vinifera varieties, because it is considered advisable to determine in advance of the appearance of phylloxera which resistant varieties are best adapted to the conditions there. So far as information has been obtained, phylloxera has not yet gained a foothold in California south of Tehachapi Pass.

At the Plant Introduction Garden at Chico, Cal., cuttings of 66 varieties of resistant stocks have been planted in the nursery to determine their relative rooting quality as affecting their commercial value as graft bearers. This feature of the work is of immediate importance and must be conducted simultaneously with the determination of adaptability of varieties to soils.

Local conditions at Southern Pines, N. C., and Earleton, Fla., having made the further maintenance of the small vineyards at those points inadvisable, these were discontinued at the close of the last fiscal year. Cuttings of all the varieties in them which were not already included in the California collections were made, and these varieties were transferred to the Oakville and Fresno vineyards. At Southern Pines certain of the Vinifera varieties on resistant stocks, tested during the period of seven years through which that vineyard was maintained, were found to resist rot and adverse climatic conditions better than most of the American varieties at present grown in that section. The principal exceptions to this rule were varieties of the Æstivalis type and its hybrids, such as Lenoir, Delaware, etc. At the same time, with proper fungicidal treatment, these varieties produced as much as or more fruit than the American sorts grown there and of a superior quality. As noted in a former report, it has been found necessary in Florida to employ very different methods of pruning and training than those practiced in other portions of this country. Several Vinifera varieties grown at the Subtropical Laboratory at Miami, Fla., where modified methods are now under test, have yielded quite promising results. The Æstivalis stocks appear to be of greatest promise under Florida conditions.

As in former years, limited distributions of cuttings of grape varieties have been made, and investigations of the conditions of the viticultural industry in districts where such work appears most urgent have been undertaken, so far as circumstances would permit. During the year a systematic collection of specimens of fruit of the Rotundifolia type of grape has been begun, and samples of a number of interesting varieties were received from various parts of the South as the result of the publication of an invitation for sending such samples which was disseminated through the local press of the South Atlantic and Gulf States. The importance of this species to the region in question is very evident, as it is in all particulars well adapted to the conditions there and apparently capable of rapid and considerable improvement in its cultural features.

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The demand upon the Bureau for information on viticultural topics is increasing very rapidly, and covers the whole range of grape growing, including the marketing of the fruit and the manufacture and disposal of its various products, such as unfermented juice, vinegar, wine and kindred products, raisins, etc.

FRUIT DISTRICT INVESTIGATIONS.

The fruit district investigations have been continued during the year under the direction of Mr. H. P. Gould, assistant pomologist in charge. The work has been chiefly along lines indicated in former reports, as the problems under investigation are complex and require to be studied for considerable periods before safe generalizations for the guidance of orchardists can be formulated.

The phenological work, which began in 1902, has been continued in accordance with former plans. A large amount of data is being accumulated, and it is proving of much value for reference in connection with the selection of varieties for mixed planting which blossom simultaneously, to insure cross-fertilization, and in ascertaining the duration and exact time of the blossoming periods of particular varieties in those portions of the country where it is desired to pursue other investigations relating to orchard trees. The data collected include, among other things, the exact time of ripening, and this information is of much assistance in selecting varieties for planting which will ripen in any desired sequence. The records are now being compiled as rapidly as possible, with a view to their future publication. That portion of the data which relates to the South Atlantic States, covering the adaptability of orchard fruits to those States, is being included in a report for publication in the near future. It seems advisable to continue this work on its present basis for a considerable period, in order that the records may include the probable range of climatic conditions in the several important districts.

The investigations of the adaptability of varieties to conditions in the Piedmont and Blue Ridge areas of the South Atlantic States, which have been in progress for three seasons, were continued during the autumn of 1904, and have now progressed to a point where the presentation of the data in bulletin form seems warranted. The results have already been compiled, and it is expected that the manuscript will be submitted in the near future.

As noted in the last report, investigations of the orchard conditions of the Ozark region of Missouri and Arkansas have been undertaken. Special attention was directed to this region on account of its apparent relative importance in the pomological development of the country; the fact that the fruit-growing interests there are in their earlier stages of development, so that information regarding the value of varieties can be promptly turned to account in the planting of new orchards, and because of the similarity of the general conditions in the Ozark region to those existing in the Piedmont and Blue Ridge areas of the South Atlantic States.

More detailed investigations than those of the previous season were made in this district during August and September, 1904. Apples and peaches are the principal orchard fruits of the region.

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The unfavorable climatic conditions which prevailed during the winter and spring of 1904 greatly reduced the crops there, but it was found possible to study the conditions more closely than has hitherto been done and to make some important observations on the relative susceptibility of varieties to the adverse conditions which had prevailed.

Further studies of the early-apple industry on the Delaware peninsula and in New Jersey have been made. It is hoped that these can be concluded during the present season, so that the results can be made available to planters.

MISCELLANEOUS PROBLEMS.

The investigation of cultural varieties of the pecan has been continued, detailed historical and descriptive accounts of the ten earliest introduced varieties having been published in the Yearbook for 1904. A systematic study of the peach and of small fruits has been continued, data upon these and other allied subjects being accumulated as opportunity is afforded in connection with other work. A beginning has been made in the study of the farm fruit-evaporating industry. A considerable volume of data upon methods of cooperative packing, forwarding, and marketing fruits has been accumulated.

PLANS FOR FUTURE WORK.

FRUIT MARKETING.

The continuation of cooperative experimental shipments of early apples and peaches is contemplated, necessarily subject, as to magnitude and locality, to the climatic and crop conditions as they develop throughout the season. Different packages and methods of packing and forwarding will be tested to obtain additional data on these complex questions. Special attention will be given to the continuation of investigations begun last year on the advisability of careful grading of winter varieties of apples for export and the relation of such grading to the types of package in which the fruit should be shipped.

Systematic experimental investigation of the possibility of developing a foreign demand for oranges and pomelos from California and Florida is contemplated. Other important features of closely related work are noted below under the heading of "Fruit transportation and storage." Systematic investigation of cooperative fruit packing and handling will be continued, as it is recognized that in many sections of the country joint effort by growers is important in developing fruit export trade.

Cooperative work with the experiment stations in Porto Rico and Hawaii to improve the carrying quality of fruits shipped from those islands is under consideration.

FRUIT TRANSPORTATION AND STORAGE.

Plans for future work in fruit transportation and storage include the following:

(1) A continuation of the investigation of the influence of cultural methods on the keeping quality of fruits, both as an independ-

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ent study and in cooperation with the New York State Experiment Station upon certain phases of the work.

(2) A preliminary investigation of the commercial methods of picking, handling, and storing on the keeping quality of fruits grown in the Rocky Mountain and Pacific coast regions, with which will be included the investigation of certain fruit-transportation problems closely related thereto.

(3) A continuation of the study of the adaptability of different systems of cold storage to fruit-farm conditions.

(4) A continuation of the study of the causes of losses in perishable fruits in transit.

(5) A continuation of the study of the causes of losses in citrus fruits from decay in California and an extension of the work to cover practical methods of applying the results worked out by the Department.

(6) A study of the problems of handling and curing lemons, in cooperation with the other offices of the Bureau of Plant Industry and in harmony with the work of the University of California.

(7) A continuation of the study of the development of fruit fungi in different storage temperatures, in cooperation with the Pathologist and Physiologist of the Bureau.

(8) A continuation of the investigation of chemical changes in stored fruit, in cooperation with the Bureau of Chemistry.

VITICULTURAL INVESTIGATIONS.

The experimental vineyards in California have now reached that stage where they demand constant attention and observation to interpret the various phenomena occurring therein. Their care and maintenance also require careful attention, and they may reasonably be expected to begin to throw light upon several of the vexed vineyard problems in the near future. Additional plantings of stocks and a continuation of the grafting of Vinifera varieties upon them will be continued during the year.

Additional tests of the rooting qualities of the resistant varieties now growing in the experimental vineyards will be made, and experiments in the improvement of varieties through selection from individual vines showing exceptional merit in one or more important characteristics will be begun. Efforts will be made to interest intelligent growers to pursue similar lines of investigation in their own vineyards. For this purpose a limited distribution of cuttings of promising sorts is contemplated.

The establishment of an additional experimental vineyard in California, to be located in the foothill region of the Sacramento Valley, where the growing of table grapes is an important industry, is under consideration.

A systematic survey of the South Atlantic and Gulf States, with a view to determining the exact present status of the Rotundifolia type of grape as it has come into cultivation upon farms and in gardens, is contemplated. In connection with this work, the establishment of a cooperative vineyard in which the more promising varieties of this type can be assembled is under consideration. It is expected that one assistant will devote his entire time to this work during the larger part of the coming year.

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Field investigations of special regions are contemplated as opportunity arises, as it is believed that much is accomplished in this way through conferences with growers, addresses at meetings of their associations, and through direct personal contact with the industry.

The investigation of the resistant-stock question in the leading vineyard districts of Europe is considered very important, and it is hoped that this can be accomplished during the year.

FRUIT DISTRICT INVESTIGATIONS.

While the exact field of operations for the fruit district investigations necessarily depends considerably upon the climatic conditions during the winter and spring of each year, the following lines are under consideration for the fiscal year 1906:

Studies will be continued in a few representative orchards in the Piedmont and Blue Ridge areas for the purpose of more detailed research in relation to certain important problems, such as the better adjustment of varieties to particular conditions and the behavior of some of the more recently introduced sorts.

Attention will also be turned to the orchards of the Appalachian Valley, which has attained distinct importance as a commercial fruit district.

A more complete and comprehensive survey of the Ozark region is planned for the autumn of 1905 than has been possible heretofore, and it is probable that it will be advisable to continue investigations in this district during the season of 1906.

It is expected that more systematic attention will be given to new or little-known varieties in the effort to determine their value in developing and extending the fruit-growing interests. Local varieties unknown outside of the immediate vicinity of their origin and possessing decided merit are frequently found. Many other varieties which have not been widely disseminated are probably worthy of more general culture.

SYSTEMATIC AND ECONOMIC BOTANY.

The work on systematic and economic botany is in charge of the Botanist, Mr. F. V. Coville, who reports on the following lines of investigation:

REGULATION OF GRAZING ON THE PUBLIC LANDS OF THE UNITED STATES.

At the request of the Commission on the Public Lands, Mr. Coville was assigned on June 6, 1904, to the task of preparing a report which would indicate whether by some new system of management the stock-carrying capacity of the public grazing lands could be increased and at the same time homestead settlement could be stimulated. In May, June, and July, 1904, Mr. Coville examined the system of grazing leases operated by the State of Texas and the system of grazing permits followed by the United States Office of Indian Affairs on the San Carlos and White Mountain Indian reservations of Arizona. In August and September the grazing-lease system applied by the State of Wyoming to her State lands and that applied by the Northern Pacific Railway to the arid lands of that railroad in the State of

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Washington were examined. Mr. Coville's report on these investigations forms a part of the report of the Public Lands Commission, printed as Senate Document No. 189, Fifty-eighth Congress, third session, and has been reprinted as a part of Bulletin No. 62 of the Bureau of Forestry. The report contains, in addition to an outline of the systems of leasing large areas of grazing lands already mentioned, the outline of a proposed system for the regulation of grazing on the public lands of the United States, which it is believed would increase their grazing productiveness, provide for their orderly occupation and use, and preserve them for actual homestead settlement. The proposed system would be self-supporting.

USEFUL PLANTS OF GUAM.

During the past year Mr. William E. Safford, assistant botanist, completed his "Useful Plants of the Island of Guam," which has been published in Volume IX of the Contributions from the United States National Herbarium. Mr. Safford spent a portion of the years 1886, 1887, 1894, 1899, and 1900 in the Pacific islands as a lieutenant in the United States Navy, and from August, 1899, to August, 1900, he acted as assistant governor of the island of Guam. His notes and observations on useful plants of the Tropics, collected during these years, are comprised in a publication which covers 415 pages. The work is illustrated by 70 plates, including a map of the island of Guam, contains descriptions of the principal plants used for food, fiber, starch, sugar, and forage in the Pacific islands recently acquired by the United States, and gives the names by which they are known not only in Guam but in the Philippine Islands, Samoa, Hawaii, and Porto Rico. The methods of cultivating and propagating the more important species, such as arrowroot, copra, and cacao, and of preparing the derivative products, are described. The publication will be widely useful as a work of reference for American travelers and investigators.

LIBRARY FACILITIES FOR BOTANICAL WORK.

Owing to the inadequacy of library facilities in Washington for the botanical work of the Government, Congress made a special provision several years ago, in the agricultural appropriation bill, for the purchase of necessary botanical works out of the funds for Botanical Investigations and Experiments. Similar provision has been made annually. By this means the Department has been enabled to secure not only the current publications which are necessary to any botanical library, but to purchase needed books, out of print and valuable, in such a way as to strengthen greatly the library facilities in Washington and make it possible for botanists employed by the Government as well as those visiting Washington and temporarily conducting investigations there to secure the books necessary for the proper completion of their researches. By a system of cooperative purchases between the Department of Agriculture, the National Museum, and the Library of Congress, the funds for botanical works at the disposal of these institutions have been used in such a way as to avoid duplication and to secure the most valuable books

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and those most needed in our botanical investigations. A continuation of the same procedure will ultimately result in the accumulation by the Government of a library which will be of inestimable service to botanical research throughout the United States.

FLORA OF ALASKA.

The work begun in 1899 on the preparation of a flora of Alaska has so far progressed that it is expected to complete it during the coming year. The development of mining in Alaska within the past ten years has added to the demand for an authoritative work on the plants of that region, and has much increased the prospective usefulness of such a publication. Situated as miners, prospectors, and explorers are, in regions often remote from civilization, and dependent as they often are for food, fuel, and utensils upon the natural vegetation of the region, a good working botany, particularly when adequately illustrated, will find a large field of usefulness.

DOCTOR PALMER'S COLLECTIONS OF ECONOMIC MEXICAN PLANTS.

For more than twenty years Dr. Edward Palmer has been engaged in making botanical collections in the Western States and in Mexico, and during that time he has paid special attention to the plants used by the aborigines for their various domestic purposes. The large and valuable mass of material thus accumulated has been placed in the hands of this Office, and is now being worked over in a systematic manner for the purpose of putting it in form for publication. This work will be carried forward during the coming year.

MANUAL OF THE GRASSES OF THE UNITED STATES.

Since almost the beginning of the Department of Agriculture, one feature of its economic activity has been the encouragement of the forage resources and forage productiveness of the United States. In the progress of these investigations very large collections of grasses have been brought together, and from time to time various papers, based on these collections and containing descriptions of new species and other information of botanical interest and value, have been issued. During the past year all these collections, known as the grass herbarium, or agrostological herbarium, have been placed in the hands of the Botanist, and it has been determined to utilize all the accumulated material in the preparation of a manual of the grasses of the United States, suitable for the use of botanists and agriculturists. This work will be in the hands of Mr. A. S. Hitchcock, Mr. P. L. Ricker, and Mrs. Agnes Chase.

FIBER INVESTIGATIONS.

The work on fiber plants is being conducted by Mr. L. H. Dewey, and may be briefly reviewed under the following heads:

SISAL.—The most important plant fiber imported into the United States is sisal, the principal fiber used in making binder twine. Most of the sisal comes from Yucatan, the native home of the hene-

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quen plant, from the leaves of which this fiber is obtained. Mr. L. H. Dewey, Botanist in Charge of Fiber-Plant Investigations, has visited Yucatan to study fiber production there. The sisal fiber of commerce is obtained from plants set out in cleared fields and to some extent cultivated. All of the plants cultivated commercially for fiber in Yucatan belong to one type or variety, *Agave rigida elongata*, called there "sacci" to distinguish it from the variety "yaxci," *Agave rigida sisalana*, which has been introduced into southern Florida and is now cultivated in the Bahamas, Cuba, and Hawaii. A third form, called "zapupe" or Tamaulipas henequen, is beginning to be cultivated in the States of Vera Cruz and Tamaulipas, in eastern Mexico. All of these forms are called henequen in Spanish America. The Yucatan "sacci" differs from the others in developing an elongated trunk 2 to 5 feet in height, bearing leaves about 2 inches thick at the base and armed with marginal spines. This plant, propagated from two-year-old suckers, produces its first crop of leaves during the sixth or seventh year, and continues to produce about 16 leaves per plant every six or eight months for a period of ten to twenty-five years. The Bahama plants propagated in the same manner produce the first crop of leaves during the third or fourth year, and produce annual crops of about 20 leaves per plant thereafter for a period of five to ten years. The life of the plant is somewhat longer in Cuba. The Bahama plant, carefully cleaned, produces a finer, whiter, and softer fiber than the Yucatan plant, but its life is shorter and it is somewhat less productive.

Flax.—In cooperation with the Office of Seed and Plant Introduction and Distribution, flaxseed obtained by Prof. H. L. Bolley in Russia in 1903 was distributed in the spring of 1904 for trial at several experiment stations, and also to a few private farms where flax is cultivated. The results of these trials indicate that some of the types of the Pskoff region are very promising for fiber flax in this country. Seed was saved in many places for further trial during the year 1905. Some of the seed types of southern Russia give promise of value for the production of linseed in the drier prairie region from South Dakota to Texas. Improved machinery for thrashing flax, and also improved methods of breaking the retted straw and preparing the fiber, give promise of the establishment of the flax-fiber industry on a more extensive scale in this country.

Hemp.—After repeated failures in the South Atlantic States, hemp has finally made a successful growth at Brunswick, Ga. Increased areas have been sown this year in Michigan, Minnesota, and Nebraska, but nearly all of the hemp produced in this country is still grown in central Kentucky, where the methods of retting and preparing the fiber are best known.

The most important fact to be recorded in connection with the hemp industry during the past year is the successful operation of a machine brake in the fields in Kentucky. This machine breaks the retted stalks and cleans the fiber, producing clean, straight fiber equal to the best grades prepared on the hand brakes, and it has a capacity of 1,000 pounds or more of clean fiber per hour. So far as we have any record, this is the first machine having sufficient capacity to be

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commercially practical that has cleaned bast fiber in an entirely satisfactory manner.

RAMIE.—A small plat of ramie has been grown in the testing garden during the past six years. The plants produce two crops of stalks each year. Some of the stalks have been used to test decorticating machines, but thus far without any marked success. The most promising results have been obtained in cleaning dried stalks on a hemp-breaking machine. The fiber thus cleaned retained some pieces of hurds and outer bark, but a sample of it was degummed, producing a very good grade of filasse. All commercial ramie is now cleaned by hand from green stalks immediately after they are cut, but when grown on a larger scale, involving the use of machinery, it is possible that the crop may be handled more economically by drying the stalks. If decorticated green the work must be done immediately after cutting, since a delay of even an hour, permitting the stalks to wilt with the leaves on them, will result in the loss of the fiber which clings to the leaf stems.

A market for ramie goods has been established in this country, and there is an increasing demand for ramie fiber in European mills. The ramie plant can be propagated readily from seeds or transplanted roots, and it can be grown without difficulty in suitable soils from Virginia to Texas and in central and southern California, but its cultivation on a commercial scale in this country can not be recommended until a successful method for cleaning the fiber has been introduced.

FIBER PLANTS IN PORTO RICO.—At the request of the Porto Rican government an investigation has been made of the fiber plants now growing in that island, and the conditions relative to the introduction of others. The principal fiber plants now growing in Porto Rico are the Porto Rican maguey (*Furcræa fœtida*), cocuiza (*Furcræa cubensis*), emajagua (*Paritium tiliaceum*), and sansevieria (*Sansevieria guineensis*). None of these plants is used commercially for fiber production. Hammocks and domestic cordage are made to a small extent from Porto Rican maguey, which is the same plant as that cultivated in the island of Mauritius for Mauritius fiber. The bast fiber of emajagua is stripped from the stalks and twisted by hand into cords, largely used on the island for halter ropes and for anchor ropes and other purposes about small boats.

Abacá (the "manila hemp" plant, *Musa textilis*) and sisal (*Agave rigida sisalana*), are growing at the experiment station at Mayaguez from seedlings and rooted bulbils furnished to the station by the Bureau of Plant Industry. The growth of these plants indicates that in favorable situations they may be cultivated successfully in Porto Rico. On the south side of the island, between Yauco and Ponce, there are considerable areas of dry, rocky limestone soil very similar to that producing the best sisal plants in Yucatan and the Bahamas. Abacá will grow best on hillsides where there is a heavy rainfall and good drainage. Since sisal and abacá are most extensively imported, and most in demand by our manufacturers, efforts should be made to produce these fibers in Porto Rico.

CLASSIFICATION OF VARIETIES OF COTTON.—Cotton has been for many years one of the most important crops of this country, yet no

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adequate descriptions have been written of the numerous cultivated varieties and no attempt has been made to classify them systematically. There are confusion and uncertainty even about the botanical classification of the species in cultivation.

Advantage is being taken of the facilities offered by the large collection of cottons cultivated in connection with the boll-weevil investigations in Texas to study these plants in the field. This work is being done, independently of the boll-weevil work, by Mr. Fred J. Tyler, of the Office of Botanical Investigations. He is making a detailed study of the plants in the field, supplementing his notes with a full series of specimens and photographs taken at various stages, and also collecting all information available on the published descriptions of various kinds of cottons in all parts of the world. The data thus obtained will be used in the preparation of a classification of the species and varieties of cotton, and descriptions by means of which the varieties may be recognized or distinguished from each other.

PLANS FOR FUTURE FIBER WORK.—During the coming year plans are made for continuing the study of cotton varieties, conducting further investigations with a view to the introduction of fiber plants into Porto Rico and Hawaii, the study of improved methods for the preparation of flax, hemp, and ramie fibers, and an investigation of the possibility of utilizing the lechuguilla plants of western Texas for the production of brush fiber.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

Drug and Medicinal Plant Investigations and Poisonous Plant Investigations, as well as Tea Culture Investigations, are in charge of Dr. Rodney H. True.

DRUG AND MEDICINAL PLANT INVESTIGATIONS.

FIELD WORK.—In the work with drug and medicinal plants field investigations have been carried on at three principal stations: At Burlington, Vt., in cooperation with the Vermont Agricultural Experiment Station; on the Potomac Flats, near Washington, D. C., and at Ebenezer, S. C., in cooperation with Mr. J. W. King.

During the past year about 50 species of drug-producing plants have been under observation at Washington, D. C. Since most of the plants under study have never been grown in this country on a commercial basis, their behavior is observed in cultivations on a small scale. Germination, methods of cultivation, and treatment are studied. Among the wild plants undergoing domestication a number of species of some importance to the drug market which have hitherto proved stubborn in the face of attempts to grow them from seed have developed a satisfactory crop from seed planted in the autumn. This is especially true of pennyroyal (*Hedeoma pulegioides*) and lobelia (*Lobelia inflata.*) The Asiatic poppy, with which some trouble has been experienced, seems also to do better when fall sown.

Golden seal, a forest plant of the Middle States east of the Mississippi, yielding a root drug now valued at from $1.30 to $1.50 per

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pound, has been the subject of study for several years. It has been found capable of yielding a good article under cultivation, and a paper by Miss Alice Henkel, assistant, and Mr. G. Fred Klugh, scientific assistant, describing the methods of propagating, cultivating, and handling this plant has been published.

Among other valuable wild plants under study may be mentioned the tree producing cascara sagrada bark (*Rhamnus purshiana*), the echinacea or purple coneflower of the drug market (*Brauneria pallida*), and Seneca snakeroot (*Polygala senega*).

Among the many kinds of foreign drug plants under investigation the poppy seems to demand conditions somewhat different from those met with in our Washington garden. In this plant a diseased condition occurs, presumably of physiological origin, and having very bad results. Belladonna culture from fresh seed is readily accomplished, beautiful crops of fruit, leaves, and roots being grown. Two-year-old plants reach a height of between 4 and 5 feet. Since this country is importing belladonna products largely and paying at the present date from 9 to 10 cents per pound for the cured leaves and 10 to 11 cents for the dried root, there seems to be here a promising article for American gardeners to consider. As is the case with most single articles used in drug commerce, the demand is not unlimited and the cultivation of this plant should be taken up in connection with other things.

Foxglove (*Digitalis purpurea*) culture is also carried on with success at Washington on rich and well-drained soil. Since it occupies the soil for two years and yields only the leaves at flowering time, the outlook for good financial returns is hardly as favorable as in the case of belladonna.

Paprika peppers from Hungarian seed do well at Washington, yielding finely until frost. The cured peppers have a fine appearance, but are somewhat more pungent than they should be. Possibly choice varieties, which would have the desired mildness, might be imported.

Perhaps this mention will suffice to indicate that progress is being made in learning the field aspects of the situation. A bulletin giving the results of the work in greater detail will probably be presented for publication in the near future.

The work at Ebenezer, S. C., has been on a somewhat larger scale than at Washington. Several hundred pounds of stramonium leaf were grown, cured by artificial heat in a tobacco barn of the type used for curing bright tobacco, and marketed at a price in advance of the highest quoted figure. The superior finish of the drug was the occasion of this favorable sale. A like quantity of paprika peppers was also grown, cured without artificial heat, and sold at a very encouraging figure, although the curing was not all that might have been desired. The greatest success financially was obtained in an experimental plat of American wormseed (*Chenopodium anthelminticum*). This plat yielded at a rate of somewhat over a thousand pounds per acre and gave a total income nearly double that of cotton grown on a like type of soil. The following spring the tops were found to renew themselves from the roots, saving the expense and time of reseeding.

At Burlington, Vt., we had our best crop of poppies, of both the

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blue and white seeded varieties. This material gave a favorable yield of crude morphine. Further experiments on a commercial basis are planned in order to determine whether the culture of the poppy for its seeds and for its morphine may be made successful financially. Work with Seneca snakeroot is being continued with somewhat more hopeful results. As yet, however, we have not succeeded well with this plant.

For two seasons Mr. W. O. Richtmann, expert in pharmacognosy, has visited Florida to study the camphor situation. He has found that the fresh leaves and twigs of trees grown there contain from 1 to 1½ per cent of crude camphor. In view of our present rate of annual importation, which is more than $750,000 worth, the question of cultivating the camphor tree in hedges and clipping it for distillation for camphor products seems worthy of investigation.

In order to test the practicability from a financial standpoint of growing drug plants in this country, a series of tests on a larger scale in different localities has been planned in cooperation with the Office of Seed and Plant Introduction and Distribution. Poppies, camphor, and licorice are receiving especial attention. This is a very important phase of the investigation, and complements most satisfactorily the preliminary work in the testing gardens and field.

At the present time, although the United States is one of the greatest hop-producing countries of the world, there seems to be a rather pronounced discrimination in the matter of price against the American product in comparison with hops from certain European sources. This may be due to the fundamental properties of the hops or to the manner in which they are cured and otherwise handled, or to several combined causes. At the urgent request of important hop growers, Doctor True, while in the West working on other problems, continued his trip to the Pacific coast to look over the situation. The opportunity to aid this line of agriculture through a study of the methods of handling and of the properties of the product in relation to the market value seemed very good. Terms of the most liberal cooperation were offered to the Department.

LABORATORY WORK.—During the year Mr. W. O. Richtmann has succeeded in perfecting on a laboratory scale a method of extracting a very high grade of crude morphine from the dried tissues of the poppy-plant capsules. At present poppies are grown in large quantities in France, Germany, and in the Orient as a source of poppy seed, from which an excellent oil is expressed. The walls of the capsules have heretofore been a waste product, and should this process prove successful on a large scale the whole matter of the importation of the present crude source of morphine may be affected. This importation amounts to more than a million dollars annually.

Mr. W. W. Stockberger has made a careful study of the crude drug known as pinkroot, and has demonstrated that much confusion exists concerning the true and efficient drug. This confusion he has been able to clear up entirely. His work on this subject will soon be presented for publication.

Miss Alice Henkel has brought together, in response to very many requests for such information, a list of the wild medicinal plants of the United States mentioned in the trade lists of American drug dealers, giving the most widely used common names; the approved

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botanical names, in case of the official drugs coming within the scope of this list those of the new Pharmacopœia, and the old botanical names, in case change has been made, as well as a few words of descriptive matter, data on geographical distribution, and information as to the parts used. This list will serve as a work of ready reference for drug handlers, who find it hard in these days of shifting nomenclature to correlate common and botanical names with the plants concerned. It will also tend to unify practice in the use of names. It is believed that this bulletin will prove useful to all who may have to do with crude drugs.

PLANS FOR FUTURE WORK.—The field work should be continued in the testing gardens in the regions in which they are now located, and also at some new point in the drier, hotter part of the country. There are many important drug-plant products obtained from similar hot, arid parts of the earth which can not be studied under natural conditions at present. Provision should also be made for the expense of caring for and making observations at such a station.

The demonstration phase of the work to be carried out on a commercial scale, especially in the case of the poppy, camphor, and licorice, is an especially important line of work and should be conducted at several points suitable for each product.

In view of the situation prevailing in the hop industry, provision should be made for a thorough study of the conditions involved in hop curing and handling, with the end in view of establishing some relation between the properties determining the market value and the means of securing these properties in so far as methods of treatment may be concerned.

POISONOUS-PLANT INVESTIGATIONS.

FIELD INVESTIGATIONS.

Loco.—An experimental study of the so-called loco disease in sheep as seen in the Sweetgrass country, Montana, was made during the season of 1904 by Dr. H. T. Marshall and Prof. V. K. Chesnut as a cooperative experiment between the Department of Agriculture and the Montana Experiment Station. About 70 sheep were divided into groups and fed, some on loco, some on grass, and in various other ways handled in a manner intended to test the relation of the white loco weed (*Aragallus spicatus* (Hook) Ryd.) to the disease under study. The results of the previous year's study were largely confirmed, and the conclusion was reached that the so-called loco disease, as seen in the region in question, is a composite trouble in which the lack of proper food and the action of a series of animal parasites of the intestines and other parts are very much more prominent factors than any action which may result from the poisonous properties of the plant concerned. The investigation was continued through the past winter by Professor Chesnut in the form of a feeding experiment intended to show how far "locos" may recover under treatment and be brought into good and salable condition. Very encouraging results have been obtained, and they will be gotten together for publication in the course of the coming fiscal year. The loco question as seen under the conditions here concerned seems to

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be one of ranch hygiene. Keeping the sheep from infection from parasites and providing them with a proper supply of food are preventive measures which are likely to prove very effective. The part played by the loco plant seems to be a comparatively minor one. This result is very important in its bearings on land values in the region occupied by the loco plant. The presence of loco has become an important factor in depressing the value of large areas of grazing land. If these investigations serve ultimately to establish the nonharmfulness of loco, land values in the affected regions will tend to resume their normal basis. On the other hand, the loss in animals from some disease whose symptoms give evidence of a constant unknown agent as the primary cause is actually very serious, and future investigations along this line are of the greatest practical interest to ranchmen.

Since there is not only a so-called loco disease of sheep, but also one seriously affecting horses and cattle as well, a careful feeding experiment in cooperation with the Colorado Experiment Station has been undertaken at Hugo, Colo., in the midst of a region in which great losses have been experienced. In all, 26 head of stock are under observation, and the outcome of this work is awaited with great interest. The county of Lincoln, in which the experiment is located, appropriated $250 to aid in carrying on this work. Dr. C. Dwight Marsh, special agent, is in charge of the experiment. One of the most encouraging factors in this experiment has been the practical and generous aid Doctor Marsh has received from citizens of Hugo and of Lincoln County.

Larkspur poisoning.—In cooperation with the Colorado Experiment Station a study of larkspur poisoning as seen in Colorado has been undertaken, supplemented by a laboratory study at Washington, D. C. Much loss is met with annually in Colorado from this plant.

Bighead.—The sheep disease known as bighead, ascribed almost invariably to the action of one or more poisonous plants, is met with over a wide area beyond the Rocky Mountains, from Nevada to Oregon. Pursuant to requests from Nevada, a preliminary study of the trouble was begun last spring. In the region about Reno, Nev., and at Soda Springs, Idaho, some experimental work was undertaken in the hope of determining what causes this serious malady. The whole affected area was unusually free from the trouble and the cases were much lighter than usual. Nevertheless, some interesting negative results were obtained, and it is hoped that a further study may be possible next season.

LABORATORY WORK.

During the past year, in addition to completing the equipment of his laboratory, Dr. A. C. Crawford has given especial attention to the poisonous principles of *Zygadenus venenosus*, a frequent cause of much trouble in parts of the Northwest. The nature of these bodies is at present not well known, and it is hoped that the outcome of the study will be a practicable method of antidoting the poison. The mountain laurel (*Kalmia latifolia* L.), probably the most frequent source of loss through poisoning east of the Mississippi River, is also receiving attention.

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During the year much work has been done on a number of problems which have considerable interest for certain localities. A request was received from Arizona asking that the reported action of the creosote bush (*Covillea tridentata*), abundant in the arid Southwest, in causing abortion and even death in sheep, be investigated, a considerable loss from this cause being reported. Careful feeding experiments of the bush and of extracts prepared from it were made on pregnant ewes with negative results in every case. It appears, therefore, that if sheep are ever compelled to eat this disagreeable bush other causes of trouble, such as starvation, are also present, and are probably responsible for the abortion.

Wild lupine seeds were sent in by Prof C. C. Georgeson, of the experiment station at Sitka, Alaska, as the supposed cause of death of fowls eating them. Laboratory experiments with the seeds in question showed that when eaten in quantity the seeds were capable of killing hens. Since these seeds are reported as abundant in some localities, further losses may result from their consumption.

Wild rice collected in Minnesota as an article of food was found by Mr. C. S. Scofield, agriculturist in charge of western agricultural extension, to contain a considerable quantity of ergoty grains, which, if active, might reasonably be expected to cause serious results when eaten. At Mr. Scofield's request, the grains in question were tested in the usual way on a cock. In such an experiment the comb becomes blue in case the constricting action of the active principles on the blood vessels is present. The result was negative.

Numerous other plants or plant products were tested during the year.

PLANS FOR FUTURE WORK.

It is manifestly desirable to continue the field investigations along the line now laid down. It is plain that many popularly accepted notions as to the cause of diseases affecting western ranches are now agents of mischief in themselves. Being largely erroneous, they lead to unjust suspicions on the part of injured ranchmen and to an entirely false underrating of certain land values. Add to this the large actual loss by death of sheep, cattle, and horses from unknown causes, and the matter is easily seen to be a serious one. There is need at this time of the services of a properly trained man who can give his entire time to this line of investigation, correlate the results already achieved, and direct future investigations. The body of isolated results already obtained, the practical interest and sympathy of the ranchmen themselves, and the scope of the problems involved more than warrant such an appointment.

The laboratory work on the active principles of plants poisonous to stock and the working out of methods of antidoting or otherwise meeting the trouble is a most important line of study and should be continued along present lines. At present we are meeting with considerable difficulty in finding proper quarters for keeping animals under study. They should be so located as to have sufficient room, and in case of herbivorous animals they should have an opportunity to get some pasturage. A special small structure built for the particular needs of such work is sorely in demand. The facilities could best be obtained at the Arlington Experimental Farm.

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TEA-CULTURE INVESTIGATIONS.

The tea-culture investigations have been continued under the supervision of Dr. Rodney H. True.

RESULTS ACCOMPLISHED DURING THE YEAR.

The work on tea at "Pinehurst," Summerville, S. C., in cooperation with Dr. Charles U. Shepard, has been continued along lines previously followed, special attention being given to the improvement of factory processes in the hope of bettering the product and of replacing hand labor by machinery.

The attrition apparatus for improving the finish of the tea has been installed and tested. The chief advantages gained by this treatment have been two: (1) The appearance of the attritionized product is more uniform than in the case of the unattritionized tea, making it possible to dispense to a considerable degree with the handling for appearance; and (2) an increase in the "body" of the infusion is obtained.

In connection with the "style" of tea, it is very desirable to get a fine, tight "twist" in the leaf, a point in which the Japanese at present excel. To produce this twist by hand, while readily possible, would be out of the question in this country on account of the cost of labor. Doctor Shepard has accordingly designed a rolling apparatus for this purpose which was installed too late in the season for a satisfactory test. This season should afford an opportunity for a thorough trial. Should success result an important forward step has been taken.

The yield of finished tea during the last season showed a slight increase over the preceding year.

The Texas tea garden at Mackay has been enlarged somewhat during the past year and the tea plants have made a very satisfactory growth. The nurseries are likewise in good condition and will furnish an abundant supply of young plants needed for substantially increasing the area during the coming year. The sandy, well-drained type of soil found near Pierce, Tex., has continued to demonstrate its fitness for tea growing.

The laboratory investigations of the past year consisted of a continuation by Mr. W. O. Richtmann of his study of the processes and products concerned in determining the cup qualities of tea. The tannin and caffein content, taken in connection with the temperature of the water used and the time of extraction, are important factors. The degree of comminution, the "hardness" of the water, and other factors were studied. The results of Mr. Richtmann's investigations will be described in a bulletin in the near future.

PLANS FOR FUTURE WORK.

The field and factory work in South Carolina and Texas should be continued along present lines. In the former State emphasis should be laid on improving factory processes; in Texas, on the work of propagation and of enlarging the tea garden.

The laboratory work should be continued with especial reference to the source of the cup qualities of the infusion and the nature and origin of the aroma-giving bodies found in the tea.

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INVESTIGATIONS IN THE AGRICULTURAL ECONOMY OF TROPICAL AND SUBTROPICAL PLANTS.

The scope of the work hitherto confined to tropical agriculture has been changed so as to give it a more direct relation to the agricultural problems of the United States proper. Many of our most important cultivated plants, such as corn, cotton, beans, and potatoes, are natives of tropical America, and there are indications that much can be learned which will have a practical bearing on the culture of such plants in the United States. Mr. O. F. Cook has been designated Bionomist and placed in charge of these investigations.

WEEVIL-RESISTANT VARIETIES OF COTTON.—A continuation of the studies which resulted last year in the discovery of the weevil-eating kelep, or "Guatemalan ant," has brought to light the existence in the Guatemalan varieties of cotton of several weevil-resisting characters in addition to those which conduce to the protection of the plant by attracting the kelep.

Three features in particular give promise of practical utility if they can be secured in varieties of cotton that will thrive in our Southern States. These are: (1) Dwarf, determinate habit of growth, and early bearing, which would enable the cotton season to be made as short as possible; (2) large, firmly closed involucres which exclude the weevils from the young buds and thus shorten the period during which injury can be inflicted; and (3) the growth of new tissues (proliferation) into the weevil punctures, so as to prevent the development of the weevil larvæ. In the Kekchi cotton of Guatemala, proliferation regularly occurs both in the square, or bud, and in the boll, and results in the death of a very large proportion of the young weevils. In addition to its weevil-resistant qualities, this cotton has large bolls and lint of good length and quality. Seed of this variety has been planted in Texas for study and acclimatization.

In connection with this work the study of the kelep has been continued, by a cooperative arrangement with the Bureau of Entomology. In experiments in Guatemala these insects have demonstrated conclusively their ability to protect a field of cotton thoroughly, while in an unprotected field on the same mountain slope the crop was completely destroyed by the weevils. It has also been learned that the kelep has a new type of social organization very different from that of the true ant and resembling rather that of the honeybee. This enables it to breed with satisfactory rapidity. The kelep has also been found to thrive in much drier situations than was supposed last year.

COFFEE CULTURE.—During an expedition to Guatemala, additional information regarding the production of the high-priced coffee of that country was secured. A publication on this subject is approaching completion. United States Commissioner Robert P. Skinner, of Marseille, France, secured seeds of coffee from Abyssinia for the Office of Seed and Plant Introduction and Distribution. Plants have been grown, and it is hoped that the introduction of this stock from the original home of the species may check the tendency to more or less sterile degenerative variations by relieving the condition of inbreeding that now exists.

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RUBBER CULTURE.—It has been ascertained that the rubber tree of the State of Vera Cruz, Mexico, is different from those of eastern Guatemala or of other Central American countries, showing that there is a diversity of species as well as of climatic conditions that must be taken into account in the development of rubber production as an agricultural enterprise. Many plantations have now reached the age at which the production of commercial rubber was expected to commence, but the hopes of their promoters have not been realized. It has become more and more evident that profitable results are to be obtained only under the most favorable conditions. The facts continue to justify the conclusions stated in former publications of the Department that investments in this branch of tropical agriculture should be made with extreme caution.

RICE.—A very high grade productive strain of the Honduras type of rice was discovered in Guatamala, of which experimental plantings are being made in Texas. If the results correspond in excellence with the seed, rice planters will find it advantageous to import seed rice from Guatemala instead of from Mexico, as at present.

AVOCADO.—Several superior varieties of hard-skinned avocados were secured from Guatemala for introduction into Porto Rico. It has been demonstrated that this type of fruit will withstand shipment at ordinary temperatures during journeys much longer than from Porto Rico to New York. In cooperation with the Office of Pomological Investigations an experimental shipment of avocados was made from Hawaii to New York in cold storage. A fair proportion of the fruit arrived in good condition, thus demonstrating the feasibility of shipping avocados, even the ordinary soft-skinned sorts, in this manner.

CORN.—A preliminary survey of the corn varieties of Guatemala shows the existence of numerous highly specialized adaptations for growth under particular conditions of climate and soil. Experiments have begun in the acclimatization of some of the tropical sorts in southern Texas, where corn is now a secondary and precarious crop. The summer climate of this region is thoroughly tropical, and there is reason to believe that a canvass of the tropical varieties of corn, beans, and other crops may be of material assistance in the diversification of agriculture in the cotton belt.

EXPERIMENTAL GARDENS AND GROUNDS.

Owing to the changes made necessary by the erection of the new Department buildings, it has been found advisable to make numerous alterations in the grounds proper. Various buildings used for different lines of work have had to be moved and some torn down.

GREENHOUSE CONSTRUCTION.

The range of new greenhouses to which reference was made in the last report was fully completed during the year. The range now consists of 8 steel-frame greenhouses, each 142 feet long and 19 feet wide; 3 greenhouses 134 feet long and 16 feet 9 inches wide, and 2 houses 134 feet long and 10 feet wide. These houses are all connected

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at the north end by a one-story building, 275 feet long, 22 feet wide, and 10 feet high. This building is used for office rooms, workshops, closets, packing rooms, and storerooms. There has also been erected a slat shed, 142 feet long, 20 feet wide, and 12 feet high, for the purpose of storing grapevines, strawberry plants, and other material used in connection with the Congressional seed distribution. This shed is of service also for the preparation of compost material used in greenhouse work.

GREENHOUSE OPERATIONS IN THE NEW RANGE.

Houses Nos. 1 and 2 are devoted to the propagation and care of new plants and fruits collected by the Office of Seed and Plant Introduction and Distribution.

House No. 3 is devoted to seed testing, tea culture, and medicinal plant investigations, and to the propagation and care of a collection of cacti and succulent plants.

House No. 4 is devoted to the experimental work of the Office of Vegetable Pathological and Physiological Investigations.

House No. 5 is devoted to the propagation of plants for ornamenting the grounds, for experimental work, and for distribution.

House No. 6 contains a collection of tropical and subtropical plants.

House No. 7 is devoted to the young plants grown for stock.

House No. 8 has been planted, for experimental work, with 1,532 rose plants in 9 varieties.

Houses Nos. 9 and 10 are devoted to experimental work with vegetables.

Houses Nos. 11 and 12 have been planted, for experimental work, with 2,719 carnation plants, in 17 of the leading commercial varieties, and 735 seedling plants. These plants will be grown under glass throughout the season. Bench space has been reserved in these houses for 1,039 plants of commercial varieties and 231 seedling plants, field grown, which will be planted in the houses the latter part of August, 1905. The total number of carnations planted in the houses will be 3,758, in 17 of the leading commercial varieties, and 966 seedling plants. The seedling plants are the result of crosses made last winter.

House No. 13 is devoted to growing a collection of chrysanthemum plants in pots for our annual show. This collection is composed of 2,100 plants in 113 varieties, and 70 seedlings; 63 of the varieties were selected as the best of the collection grown last year; 50 varieties are new, selected as the best of those disseminated in 1905, while the 70 seedling plants are the result of crosses made by Mr. George W. Oliver last autumn.

GREENHOUSE OPERATIONS IN THE OLD RANGE.

House No. 1 in the old range of greenhouses is devoted principally to a collection of economic plants.

House No. 2 has been allotted to Normal School No. 2, of Washington, D. C.

House No. 3 was turned over to the Bureau of Soils for experimental work.

House No. 4 has been allotted to Normal School No. 1, of Washington, D. C.

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House No. 5 is devoted to a collection of citrus and other tropical fruits.

House No. 6 is devoted to a collection of 81 varieties of European grapes.

A temporary sash house, 90 feet long, 11 feet wide, and 10 feet high, was built by our carpenter to make additional room for the experimental work of the Office of Vegetable Pathological and Physiological Investigations.

PLANTS PROPAGATED AND DISTRIBUTED.

During the year there were propagated and distributed 92,795 plants, representing 60 different species and varieties.

GENERAL IMPROVEMENTS.

The low ground between Twelfth and Fourteenth streets NW., which had been raised an average height of 2 feet, was graded, heavily manured, limed, plowed, surfaced with 3 inches of good topsoil, and sown down in grass. The terrace on the north side was sodded to prevent washouts from heavy rains.

A portion of the ground between Thirteenth street NW. and the new greenhouses was graded, heavily manured, plowed, and harrowed, to serve as a trial ground for a collection of miscellaneous plants, clover, and alfalfa. This trial ground was inclosed on the east side by a hedge of Rugosa roses and a temporary wire-mesh fence.

The strip of ground at the south front of the new greenhouses was filled to an average height of 18 inches, composted, and sown down in grass, outlined with sod. A walk 12 feet wide was made with ashes along the south end of the range of greenhouses and a hedge of *Berberis thunbergii* was planted on the west front.

An open trench on the west front of the grounds, which carried off surface water from heavy rains, was filled, graded, surfaced with topsoil, and sown down in grass.

A walk was cut across the lawn beginning at the northwest corner of the terrace and ending near the new range of greenhouses. This walk is 720 feet long, 5 feet wide, and 6 inches deep, and was made with ashes, watered and rolled with a heavy stone roller. The soil removed in making this walk was used in grading the south front of the new greenhouses.

During the season the lawns were mowed and their edges trimmed as often as required to maintain them in good condition. The asphalt roads and walks were swept daily and the gravel roads were kept clean and free from weed growth, and parts of the gravel roads were resurfaced with bank gravel. Dead branches were removed from the trees and shrubs. The privet, Osage orange, and arbor vitæ hedges were trimmed twice during the season.

A strip of ground east of the old range of greenhouses was devoted to school garden work.

ORNAMENTAL PLANTING IN THE GROUNDS.

A collection of 10,000 standard sorts of hyacinth, tulip, and narcissus bulbs was planted in the autumn for display in the early spring.

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A collection of 5,746 bedding plants, in 45 species and varieties, and 706 tropical plants, in 30 species and varieties, was planted in beds in the early spring for summer decoration, in cooperation with the Office of Seed and Plant Introduction and Distribution.

A valuable collection of 6,000 gladiolus bulbs and an extensive collection of garden annuals grown from seeds were planted in our trial grounds. There were also planted in our trial grounds 5,564 hybrid lettuce plants for seed selection.

The major portion of the trees and shrubs in the grounds were labeled during the past season.

SPECIAL PROBLEMS.

During the year some special lines of work have been carried on, mainly in the direction of the improvement of plants by crossing and hybridizing, and the testing of new, rare, or little-known specimens received from various sources.

HYBRIDIZATION OF CLOVER.—The hybridization work on clover, which was referred to in the last report, was continued and a number of new types were secured, which have been planted out of doors and are being tested there.

IMPROVEMENT OF LETTUCES.—In connection with the improvement of lettuces, referred to in the last annual report, special field trials have been made of the crosses, and the more desirable types have been marked for further selection experiments. This work is designed primarily, as already pointed out, to secure practicable new types of lettuces especially adapted to growing under glass. As a basis for the work, after trying many types it has been found that the most satisfactory results have been secured in the crossing of a loose variety known as Grand Rapids with a heading sort known to the trade as Golden Queen. The object is to secure a type of lettuce which can be grown under glass, which will mature quickly, head readily, and will not be subject to such serious troubles as leaf-brown, stem-rot, etc. Grand Rapids lettuce has many hardy qualities, but it is a loose form and will not sell in our eastern markets. The leaf is of good color, is tender, and somewhat curled. The Golden Queen is a small heading type of good color, and is a rapid grower. The types which have been secured by crossing are of many variations, and careful selection will be necessary to fix the desired forms.

It is interesting to note that, so far as known, this is the first attempt that has been made to improve lettuces by crossing. The lettuce types now commonly on the market are very well fixed, and the only improvements which have been made in them in recent years have been through selections. By the method of crossing, which at first was thought to be quite impracticable, many new types have been secured, and these will readily form the basis of extended future work in selections.

TOMATOES FOR GROWING UNDER GLASS.—Owing to the increasing interest in forcing tomatoes under glass, considerable work was done last year in the testing of new varieties from foreign countries. Twenty-five or thirty varieties were tested in this way and some

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crossing work was inaugurated. The object of this work is to secure, if possible, types which will be better adapted for forcing than those we now have on the market.

CELERY IMPROVEMENT.—Experiments were also inaugurated in the matter of improving the various types of celery. Some of the more common types now in use are objectionable on account of stringiness, tendency to scald, etc., and the experiments in question have for their object the securing of better types by crossing.

IMPROVEMENT OF METHODS IN THE PROPAGATION OF TROPICAL FRUITS.—As a feature of the work in Experimental Gardens and Grounds, efforts have been made from time to time to improve the methods now in vogue in the matter of propagating tropical fruits. The agricultural explorers of the Bureau of Plant Industry are constantly sending in many kinds of new fruits, all of which must be cared for and, if found valuable, propagated and disseminated. Special attention has been given in recent years to the mango. A fine collection of mangoes has been secured through the Office of Seed and Plant Introduction and Distribution, and Mr. George W. Oliver has been engaged in propagating these by inarching. Collections of mangoes have been sent to Florida for testing at a number of places. Some attention has also been given to mangosteens and other tropical fruits for special use in Florida and in the tropical possessions of the United States.

PLANS FOR FUTURE WORK.

The general work of propagating and disseminating plants as indicated for the last year will be continued. Special attention will be given to tests of fertilizers on soils and to the growing of carnations. Work will also be inaugurated in the matter of selections of carnations with a view to securing by this process better blooming and more vigorous types. This work will necessarily have to be continued for a number of years. To carry it out successfully, type plants must be selected and records made of the number of flowers cut and when they were cut. Vigor of plant, habit of growth, and other general characters will have to be considered in connection with this problem. Propagation will only be made from the types giving the most flowers at the proper seasons. It is proposed to continue this work along lines similar to those followed for violets a few years ago, which in the course of five years were shown to have resulted in increasing the average yield from 50 to about 90 flowers per plant. Tests also will be conducted in the matter of field versus house grown carnations, the same varieties being grown both indoors and outdoors during the summer and records made of the number of blooms and of the general vigor and health of plants.

Some much needed improvements in connection with the grounds will be completed during this year. The grounds around the greenhouses proper, which have been very much torn up through the erection of piling sheds, houses for holding Congressional stock, etc., will be brought into better shape and planted in ornamental shrubs and vines. It is planned to inaugurate during the year a series of experiments in testing fertilizers for lawn purposes. Portions of the lawns of the Department grounds have not been fertilized for a good many years, and opportunity is offered for valuable tests in this direction.

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Reference has been made to the greenhouses remaining on the southern portions of the grounds, which include the grapery and the large conservatory. Within the latter is housed probably one of the finest collections of economic plants in the country. Owing to the construction of the new laboratory buildings for the Department of Agriculture, it will be necessary at an early date to tear down all of these structures. Before this is done some arrangement should be made for the care of the plants now housed in these structures. The economic collections should be taken care of; also the collections of citrus fruits, especially the original navel-orange trees, which have been on the grounds for upward of thirty years. A suitable house, capable of caring for these plants, it is estimated, can be erected for about $12,000. This house might be located at the southern end of the range of new steel structures and would form a valuable addition to the working facilities of the Department.

THE ARLINGTON EXPERIMENTAL FARM.

The Arlington Experimental Farm is each year fulfilling more completely the original idea of making it a field laboratory for the various Offices and Bureaus of the Department of Agriculture. As already stated, the handling of the work is done by a committee, of which Prof. L. C. Corbett is chairman. At the present time there are five Bureaus of the Department conducting work upon the farm.

The Bureau of Forestry is conducting a portion of its willow and catalpa investigations upon the farm.

The Bureau of Entomology is establishing experimental plantations for conducting investigations with insect enemies of fruit trees, as well as plantations of mulberry trees to supply food for worms in order to provide facilities for conducting demonstration silk-culture work and investigations.

The Bureau of Chemistry is growing upon the farm some plats of grain and root crops for a check upon cooperative experiments being conducted with the various State experiment stations.

The Bureau of Soils is interested in studying the problems of soil amelioration and soil improvement upon one of the sections of the farm.

In the Bureau of Plant Industry a very considerable portion of the experimental and demonstration work of the various offices is conducted at the farm.

The Office of Vegetable Pathological and Physiological Investigations has areas devoted to corn breeding and selection, an area devoted to the cultivation of crops carrying nitrifying organisms, and fruit plantations designed for the study of diseases.

The botanical offices of the Bureau have areas devoted to fiber-plant investigations, drug and medicinal plant studies, and seed-germination tests.

The Office of Seed and Plant Introduction and Distribution maintains upon the farm its trial plats for testing the novelties of the trade, together with the seeds used in the Congressional distribution, to prove their trueness to type. It also maintains under its Division of Seed and Plant Introduction a portion of the nursery work con-

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ducted upon the farm. The trial grounds also include an extensive test of economic plants which have been introduced to the American seed trade. This work comprises 8 or 10 acres. In addition to this, the same Office is conducting a portion of its bulb tests upon areas under the control of the Arlington Farm.

The Office of Grass and Forage Plant Investigations maintains its forage-plant work and its grass garden upon areas at the farm.

The Office of the Horticulturist maintains a nursery in which are being brought together various economic, ornamental, and fruit-bearing plants to be used in the extension of the orchard and ornamental grounds upon the farm. This same Office is maintaining an annual vegetable garden and perennial fruit garden, each of which occupies 1 acre of ground. It is also making tests with flowers and vegetables in greenhouses and under cloth shade, together with an extensive field test of some 200 sorts of potatoes; part of which work is being carried on in cooperation with the experiment stations of Vermont, Wisconsin, Texas, North Carolina, and West Virginia for the purpose of determining the adaptability of some seventy sorts of Irish potatoes to the soil and climate of the different regions, as well as for the purpose of noting the influence of the climate of these regions upon the quality and yield of tubers.

SOIL IMPROVEMENT WORK.

In addition to the regular plan of soil improvement by the addition of organic matter, such as the plowing in of rye and cowpeas, the mechanical condition of the soil is being improved by deep tillage, subsoiling, and tile-draining. The areas occupied by the grass garden, vegetable garden, and fruit garden have during the year been tile-drained. The peach orchard and variety apple orchard, as well as section A of the experimental grounds north of the main driveway, are planted in cowpeas to be turned under, section A having had a good growth of rye plowed in prior to planting the peas. Pot experiments with soil from this area, conducted by the Bureau of Soils, indicate that the plowing under of a heavy growth of cowpeas is more beneficial to this land when measured in terms of crop yield than heavy applications of lime or commercial fertilizers. Field tests have verified the laboratory tests, thus confirming the wisdom of the original policy of attempting to restore these lands to a high state of cultivation by the use of green manures and by good cultivation.

NURSERY WORK.

A nursery is a constantly varying factor, but in work of the character of that conducted at the Arlington Farm it is one of the most important and one of the most interesting features of the work of the place. In certain particulars the nursery at the farm is unique. The fruit trees which are planted in the permanent plantations upon the farm are in a great measure propagated in this nursery, the scions or buds being secured from trees of known history and of varieties true to name.

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The following inventory gives the extent and variety of the plants now included in the nursery at the farm:

Economic fruits.

Apple	1,168	Cherry (various sorts)	90
Pear	38	Grapes (various sorts)	1,500
Pear, seedling hybrid (Waite's)	2,400	Currants (various sorts)	110
Peach (various sorts)	4,241	Blackberries (various sorts)	130
Plum (various sorts)	30	Raspberries (various sorts)	65
Almond (various sorts)	10		
Apricot (various sorts)	147	Total	9,931
Nectarine (various sorts)	2		

Stocks.

French apple	50	Cherry	1,000
Western apple	300	French pear	75
Dwarf apple	25	Quince	90
Kieffer pear (seedlings)	25		
Peach (native)	2,000	Total	3,865
Plum	300		

Ornamental trees.

Silver maple	250	Cytisus laburnum	50
Norway maple	600	Colutæ arborescens	45
Fraxinus excelsior	75	Citrus trifoliata	400
Fraxinus viridis	200	Juglans nigra	400
Tilia americana	400	Juglans regia	1,057
Magnolia acuminata	40	Juglans rupestris nigra	200
Cladrastis tinctoria	50	Taxodium	300
Celtis occidentalis	74	Horse-chestnut	61
Liriodendron tulipifera	700	European hornbeam	250
Platinus occidentalis	91	Larch	20
Platinus orientalis	46	Ginkgo	500
Catalpa speciosa	550	Pecan	1,000
Gymnocladis canadensis	764	Lilac	1,000
Ulmus americana	380	Mulberry (1-year plants)	1,400
Quercus laurifolia	200	Mulberry cuttings	1,000
Quercus hindsii	7	Mulberry seedlings	50,000
Quercus coccinea	10	Privet (1-year plants)	8,000
Quercus pedunculata	204	Privet (2-year plants)	1,000
Quercus palustris	900	Privet cuttings	8,000
Betula alba	200	Japan quince seedlings	283
Sophora japonica	300		
Zelkova crenata	200	Total	81,207

THE VEGETABLE GARDEN.

The home vegetable garden has been improved by the laying of tile drains, as well as by a liberal use of stable manure, which is rendered necessary on account of the long rotation of vegetables, not allowing time for improving the land in the usual manner of plowing in cowpeas.

The results secured on the vegetable testing grounds conducted by the Office of Seed and Plant Introduction and Distribution at the Arlington Farm have demonstrated the value of the site selected for this work. This tract, comprising about 4 acres, forms one of the most interesting features of the work at the farm.

SWEET-POTATO TESTS.

The extensive tests of varieties of sweet potatoes, which have been conducted for the past two years, have this year been abridged by

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eliminating all duplicate varieties and selecting those only which represent distinct types, about 25 in number. These are being propagated for future distribution to experiment stations interested in sweet-potato culture.

WHITE, OR IRISH, POTATO TESTS.

As noted in the last annual report, a collection of some seventy sorts of Irish potatoes has been grown for the past three years upon the Arlington Farm. At planting time this collection of seed so grown was divided into duplicate lots and distributed to experiment stations located in the important potato-growing districts. The seed was sent to the experiment stations of Vermont, Wisconsin, Texas, North Carolina, and West Virginia. The same varieties and the same quantities were sent to each of the stations, together with a uniform record blank for making notes upon the behavior of the sorts. This cooperative test of varieties, which is designed to extend over a period of three years, is to form the basis of further studies upon the influence of soil and climate upon the potato, as well as for the purpose of determining the adaptability of the potato to different soils for the primary object of learning the localities in which a potato of superior excellence for baking and boiling purposes can be grown.

Besides the original collection of 77 sorts of Irish potatoes which have been grown upon the place for three years, 23 sorts, including the potato novelties of the seed trade, were added during the past year, and a special importation of European varieties which in the mother country show resistance to destructive potato diseases was made for the Department of Agriculture by Prof. L. R. Jones. Ninety-nine varieties of his collection have been added to the list, making a total of 199 varieties under observation at the present time.

CELERY TESTS.

During the year a considerable area of celery was grown for the purpose of determining whether pithiness in this crop is due to stock or to variety. For this trial seeds of the same sorts were obtained from all the important seed-producing districts of the world, in order to determine whether the celery grown from seeds of any particular locality or that grown from seeds of any particular variety is less pithy than that of other sorts. The cultural tests were conducted with different implements and different systems of irrigation, to determine the bearing of this factor on the pithiness of the product.

SHADE WORK.

The cultivation of carnations, gladiolus, lettuce, tomatoes, and cauliflower under shade constructed after the manner of that used for growing tobacco was carried on during the year with very gratifying results, both with the flowering plants and the lettuce. Some very striking and interesting results were also obtained with tomatoes, but of a discouraging rather than of an encouraging economic bearing.

PERMANENT IMPROVEMENTS.

In the way of permanent improvements to the equipment of the farm, the water system, so far as storage reservoir and pumping

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plant are concerned, has been very satisfactorily worked out and installed. A brick building has been erected over the storage tank which receives the water from the Custis spring. The same building furnishes shelter for the gasoline pumping outfit, and also for the steam pumping outfit which has been installed to deliver water from the storage reservoir to the storage tank in the barn, from which place it is carried to the various buildings upon the ground. This is a very important factor in the convenience of the place. There is hardly a line of plant investigation which is not more or less directly dependent upon an adequate water supply. The present storage tank is not, however, satisfactory, and was installed simply for temporary use; and it is hoped that during the coming fiscal year a suitable substructure and tank can be erected which will be a permanent feature.

Besides the pumping station there has been erected upon the grounds a building 36 by 100 feet in extent, with a basement arrangement to provide for the storage of coal and nursery stock, a main drive floor for the storage of implements, and a second story, providing space for quarters for several employees, a toilet room, lumber storage, and a carpenter shop, together with a lunch room for the workmen. On a slightly lower level than the basement story of the main building a boiler room has been erected and provided with a steel roof, in which, at the present time, one 40-horsepower return tubular boiler has been installed. This is sufficient to furnish the necessary heat for the office rooms in the main barn building, for the lunch rooms, and for the greenhouses which are now under process of construction. This building has a brick basement and has brick for one story above ground, the second story being frame, with a shingle roof. The boiler room is entirely of brick with a steel roof.

Two greenhouses, 20 by 100 feet, have been erected with brick foundation walls connecting them with the potting room, which also has brick walls and a lean-to shingle roof. These greenhouses are divided into four rooms, each of which is piped independently, so that each room can be maintained at a different temperature and still in other respects be a duplicate of any of the other rooms. This arrangement, it will be appreciated, adds greatly to the value of the structure for experimental purposes. This design has been settled upon as the most feasible one for conducting studies on greenhouse crops and greenhouse conditions.

Further permanent improvements consist in additions to the peach and apple orchard, the installation of tile drains, and the improvement of roads, as well as the addition of ornamental trees and shrubs.

TEAMS, TOOLS, AND IMPLEMENTS.

As is necessary in all farm operations, new tools have been purchased to take the place of old ones which have become worn out, as well as to meet the demands of new lines of work.

One of the most important implements which have been added to the equipment of the farm is an automatic 4-row potato and beet sprayer, power for operating being furnished by the movement of the machine to an air pump used to charge an auxiliary cylinder or receiver, from which the air is carried to two storage tanks in which the

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spraying liquid is contained. These tanks are so arranged that they can be filled with the same or with different liquids and be discharged independently or conjunctively into a general spraying nozzle. The nozzles are so arranged as to spray both the upper and under sides of the leaves of plants like potatoes and beets, the nozzles that spray the under side of the leaves being so arranged as to follow the contour of the land rather than to be carried at a fixed height above the general surface of the ground. Experimental tests with this machine have demonstrated that the principle on which it is constructed is satisfactory from an economic standpoint.

LABORATORY BUILDING.

The experience of the fiscal year just closed emphasizes more clearly than ever before the necessity for adequate office and laboratory room at the Arlington Farm. The work of the various Bureaus and Offices associated at the farm makes it almost imperative that suitable laboratory facilities for certain lines of work be provided.

As the orchard comes into bearing, storage facilities will be necessary in order to obtain the best results.

As the studies upon forcing crops are extended, additional facilities will be necessary for this work.

The plans of the silk investigations and bee investigations of the Bureau of Entomology demand facilities for rearing worms and conducting other investigations in silk culture. Rooms provided with suitable temperature conditions are essential for further studies with bees, and since the present buildings are not provided with proper quarters for such lines of work it is necessary, if these lines of work are to be followed up in a successful and satisfactory way, that an adequate laboratory building be provided. It is believed that such a building can be erected upon the farm at a cost not to exceed $20,000.

GREENHOUSE PROBLEMS.

The greenhouse problems which were mentioned in the last annual report have in a measure been provided for in the erection of the greenhouses above mentioned. The relation of greenhouse conditions, including heat, light, and moisture, to the growth of forced crops will be continued in these houses during the ensuing fiscal year. Some of these problems have for a number of years been under investigation, but the new quarters will offer better facilities for careful investigations along this line than have heretofore been available. It is hoped that a special appropriation for horticultural investigations will be obtained, and that this important work can be more vigorously pushed.

FARM MANAGEMENT WORK.

During the past fiscal year the Horticulturist has, in conjunction with the Agrostologist, planned the horticultural work on the demonstration farms organized by the Department of Agriculture in the States of Texas, Louisiana, Mississippi, Georgia, North Carolina, and South Carolina. Besides a personal inspection of these places a crop-

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ping system for each has been outlined and proper blanks for keeping records upon the various crops grown have been provided for the conduct of the farms. The results already obtained, after one season's work upon these areas, indicate that there is great promise in this field. In fact, these farms carry the teachings of the experiment stations and of the best practitioners of the country to regions where crop failures, for one cause or another, are subjecting the farmers to extraordinary hardships. These object lessons are assisting the people of these regions to engage in a better and more stable form of agriculture, by which a livelihood is insured them even in seasons when their main staple is rendered unremunerative. This work is, at the present time, chiefly confined to the weevil-stricken area of the cotton districts of the United States. Those regions which for years have been following a single-crop system of farming naturally suffer more from any cause which interferes with the staple crop than other regions where a diversified type of agriculture is practiced.

TRUCK-CROP SURVEY.

The truck-crop survey, which was discussed at some length in our last annual report, has been taken up to some extent during the year, but because of lack of sufficient funds it can not be carried on in the way to be of greatest benefit to the truck growers of the country.

The rapid changes which are taking place in the industrial situation in the Southern States because of the establishment of cotton mills in the region, and the advent of the cotton-boll weevil in certain sections, make it of the greatest importance that the Department of Agriculture be in possession of information concerning the truck crops which can be planted advantageously throughout these States. The questions of when to plant and how to market, as well as the areas which it will be safe to devote to a given crop in any particular locality, are of the greatest economic importance to those contemplating truck work in the States referred to. It is the desire of the Horticulturist that his office possess information which it can place at the disposal of those engaging in such work, enabling the growers to meet the requirements of their conditions more successfully than they are able to do at the present time. In some localities it is absolutely necessary that the planters have crops which will give them immediate returns, and as no line of agriculture affords crops better suited for meeting such conditions than truck growing, a great demand for exact information regarding the cultivation of these crops in such localities exists.

While truck growing in many localities will probably serve only as a means of tiding the planters over a trying period—being followed only as a means of support by the people of a stricken area while they are changing their agriculture from a single crop to a diversified system—it will, in other sections, become a fixed industry and an important source of revenue.

Because of the demand for information in regard to the growing of truck crops in various localities, this Office feels the great need for further opportunity to study the conditions of the South Atlantic and Gulf States.

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NOTE BLANKS.

The note-record blanks for variety testing and for experimental work which have been prepared by the Bureau of Plant Industry for use in the experiment stations in horticultural investigations are meeting with very general adoption by the station investigators, and the end which it was hoped would be subserved by this work is assured. As rapidly as possible these note blanks are being provided to cover every standard market-garden vegetable, and as work with these different plants is inaugurated at the various stations the investigators concerned are prompt in requesting these blanks for use in their work. The result is that a duplicate record of the trials at each of the State stations is brought to the office of the Horticulturist, where the results can be compared. In a few years this collection of material will afford opportunities for studying the adaptability and longevity of varieties, as well as their geography.

SEED LABORATORY.

The work of the Seed Laboratory, under the direction of Mr. Edgar Brown, has been continued along lines similar to those mentioned in previous reports. An outline of the principal investigations carried on during the past year follows.

SEED TESTING.

During the year the work of testing seeds for vitality, the determination of mechanical purity, the examination for adulterants, and the identification of various seeds has continued to increase. A total of 9,364 germination tests was made, and 1,415 detailed tests were made for mechanical purity, making in all 10,779 combined tests for purity and germination. Of these, 5,476 tests were made in connection with investigations carried on by the Seed Laboratory, 1,513 tests for the Congressional Seed Distribution and for various offices of the Department, and the remaining 3,520 tests were requested by farmers and seedsmen. The number of samples received from farmers and seedsmen is more than twice as great as for any previous year.

In addition to the foregoing, 341 seed samples were examined for quality in a more general way for farmers, and the results of these examinations were reported by letter. Samples to the number of 732 were received from the various custom-houses during the fiscal year, and since April 1 of the present year 1,220 samples were obtained in the open market and examined for adulterants.

DETECTION OF ADULTERATION OF SEEDS.

As a result of the following clause in the act of Congress making appropriations for the Department of Agriculture for the fiscal year ended June 30, 1905, a large number of samples have been secured in the open market and examined for adulterants:

The Secretary of Agriculture is hereby directed to obtain in the open market samples of seeds of grass, clover, or alfalfa, test the same, and if any such seeds are found to be adulterated or misbranded, or any seeds of Canada bluegrass

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(*Poa compressa*) are obtained under any other name than Canada bluegrass or Poa compressa, to publish the results of the tests, together with the names of the persons by whom the seeds were offered for sale.

The first report of the investigations made possible by the foregoing clause includes only alfalfa seed and was published December 29, 1904, from the Office of the Secretary. This report shows that 23 lots of alfalfa seed were obtained which were badly adulterated with trefoil or bur clover, or both. Since the publication of this report 1,220 samples of alfalfa, red clover, Kentucky bluegrass, and orchard grass have been examined for adulterants, of which number 42 samples of alfalfa, 6 of red clover, 44 of Kentucky bluegrass, and 138 lots of orchard grass were found to be either adulterated or misbranded.

During the fiscal year ended June 30, 1905, the importation of yellow trefoil, which is used almost exclusively for the adulteration of alfalfa and red clover, was 99,248 pounds, as contrasted with 247,667 pounds in the preceding year, and 67,000 pounds for the fiscal year ended June 30, 1903. Imports of Canada bluegrass, which is used largely for the adulteration of Kentucky bluegrass or in many cases sold as Kentucky bluegrass, decreased from 732,000 pounds to 649,451 pounds during the past year. In connection with this line of investigation a paper was presented at the annual meeting of the American Seed Trade Association. The association stands ready to cooperate with the Department to guard against the importation and sale of adulterated seeds.

MISCELLANEOUS IMPORTATIONS OF GRASS AND FORAGE-PLANT SEEDS.

In obedience to the order of the Secretary of the Treasury directing that samples of all importations of grass and forage-plant seeds of 100 pounds or more be sent to the Seed Laboratory, 732 samples have been received, representing the importation of a little more than 11,000,000 pounds of seed, invoiced at a value of $760,000, in round numbers. In a large measure these importations are of seeds which could well be grown in our own country to advantage. Imports of alfalfa seed alone amounted to not far from 3,000,000 pounds, with an invoice value of a little more than $300,000. Imports of crimson, alsike, and red clovers amounted to considerably more than 1,000,000 pounds each.

Large quantities of seed of very low quality and frequent consignments of screenings continue to be imported, which, together with the large importations of trefoil and Canada bluegrass, have an important bearing on the quality of our grass and forage-plant seeds.

EXTENSION OF AREAS FOR SEED PRODUCTION.

The experiments with red clover, which is now being grown on 16 farms in 13 States, in cooperation with the Laboratory of Plant Life History, to determine the areas best adapted for seed production and the effect of "change of seed," have been continued during the year with very promising results. Similar experiments for alfalfa are now well under way, many of the plantings having already been made.

Inasmuch as large importations of both red clover and alfalfa are made annually, this work is of much importance and is being pushed

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vigorously. Other crops, in which there is a shortage of American-grown seed, will be taken up as rapidly as funds and assistance will allow.

FARMERS' INSTITUTES.

During the year a new departure was made in attending farmers' institutes for the purpose of pointing out to the farmers the great importance of buying seed of the best quality only, free from seeds of noxious weeds, and of high vitality. Six weeks were given to this work in southeastern Pennsylvania in cooperation with the Pennsylvania State Board of Agriculture, and the results have been most satisfactory, as determined by the large number of samples received for examination from farmers of that section.

HERBARIUM.

During the year a large number of samples of seeds have been received for the seed herbarium, both from American and foreign sources.

MISCELLANEOUS INVESTIGATIONS.

VITALITY OF CORN.—The work on the harvesting, curing, and storage of corn for seed purposes has continued throughout the year. Seed of the highest vitality has been obtained from corn which was allowed to mature thoroughly and then dried artificially and stored in a ventilated crib in which the temperature was never allowed to go below freezing.

Some work has been done on the drying of corn in commercial driers, the results of which show that the moisture content of fresh harvested corn can be reduced to less than 6 per cent with a temperature as high as 143° F. without any injury to the vitality of the seed.

Field tests of both these series of experiments are now in progress in Ohio and Illinois.

VITALITY OF BURIED SEED.—The first series of vitality tests have been made of the 112 different kinds of seeds which were buried at different depths in the soil. The results of these tests, described in Bulletin No. 83 of the Bureau of Plant Industry, show that many bad weeds can be eradicated by following the methods outlined.

CLIMATIC AND COLD-STORAGE EXPERIMENTS.—The experiments to determine the effect of climate and of cold storage on the vitality of stored seeds have been continued. It has been shown that most seeds, if carefully dried and placed in air-tight containers, do not lose their vitality prematurely in warm, moist climates. As a result of these investigations several lots of carefully dried seeds have been put up in air-tight tin cans and sent to the Philippine Islands. Further experiments have shown that the vitality of many seeds can be preserved if they are stored at a temperature just above freezing. A manuscript is now ready, showing that wild-rice seed, which loses its vitality in ordinary storage, does not deteriorate if kept wet at a temperature of 32° to 34° F. In these cold-storage experiments it developed that cowpeas kept in dry cold storage are not attacked by weevils. These results have been published by the Bureau of Entomology.

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STUDIES OF SPECIAL GROUPS.—The work on the commercial bluegrasses and their impurities has been completed and the manuscript is being prepared for publication. A careful study is being made of the dodders, which are doing much damage to our alfalfa and clovers in many sections of the United States. The results of these investigations will be ready for publication during the present year.

GRAIN GRADE INVESTIGATIONS.

An endeavor has been made to point out the way in which the grading of grain may be put on a more practical basis. Under the present system there are two causes which tend toward dissatisfaction and inaccuracy. One is the lack of uniformity in the requirements determining grades as laid down by the various authorities responsible for local inspection. The other and far more important cause is the lack of a sufficiently definite basis upon which the determination of grade is made.

A published statement in which the rules for grading adopted by the various boards of trade and inspection departments could be brought together for comparison would point out the present difficulties and show the importance of a more uniform system.

A large number of samples of grain have been received from the various grain-handling centers and examined to determine the actual percentages of moisture, dirt, and damaged grains in commercial grain of different grades, and as a result an outline for a set of rules on a definite percentage basis was published in Bulletin No. 41 of this Bureau, entitled "The Commercial Grading of Corn."

For several years complaints have frequently been made as to the condition in which our export grain, especially corn, arrives in European ports. During the past spring a representative of this Bureau visited the principal grain-handling ports of Europe and made careful inquiries to determine how far these reports were founded on fact and how far they are colored in the interest of the purchasers on the other side.

It is to be regretted that many cargoes of corn from the United States have arrived in European ports in damaged condition. In Rotterdam nearly 10 per cent of our corn received last season was damaged. This same condition exists in other ports and has seriously injured the reputation of corn from the United States.

The result has been an increased European trade in corn from the Argentine Republic, our only important competitor. The trade in Argentine corn has grown, both because it is sold on London rye terms and because it stands shipment better than corn from this country on account of its hard, flinty character. Our softer dent corn is, nevertheless, preferred in all the European markets, and the maintenance and increase of our export trade are dependent only on its being shipped so that it will arrive in uniformly good condition. As the deterioration of corn during ocean transit is directly dependent on the amount of moisture it contains there is an easy and practicable remedy for the present condition in artificial drying. This has been successfully tried in New Orleans, and the necessary machinery is now being installed in Baltimore and Boston. Thus far practically no attention has been given to determining just how dry grain

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should be in order to stand shipment under the varying conditions on board steamships and at different seasons of the year.

At the present time it is highly important to make a careful study of moisture in export grain in relation to its deterioration in transit. Cargoes should be sampled and the moisture determined at the time of loading and again in Europe at the time of unloading. By following this work systematically through one shipping season the relation of quality to the conditions of ocean transit would be so well determined that with the exception of accidents every cargo of grain from the United States should be delivered in European ports in as sound condition as when it leaves this country.

FUTURE WORK OF THE SEED LABORATORY.

During the current year the Seed Laboratory will take up a new line of investigation in the study of the condition of our export grains, special attention being given to corn. This work will include studies in the commercial drying of corn, its condition when received by the steamship companies, the changes which may take place during transportation, and its condition upon arrival at foreign ports.

The investigations in ascertaining the quality of grass and forage-plant seeds offered for sale in the open market and the kinds, quantity, and quality of such seeds imported will be continued.

Work has already been begun to determine standards of purity and germination of some seeds not heretofore studied carefully, and some new standard apparatus and methods of testing are to be tried.

The investigations of the conditions affecting the vitality of seeds, such as maturity, climate, temperature, storage, etc., together with the best methods of handling seeds in the trade to preserve vitality, and studies to determine the fundamental principles upon which the vitality of seeds depends are to be continued in various phases.

Closely allied economic seeds, such as the rye grasses and the fescue grasses, which are difficult to distinguish in the trade, are to be studied and their distinguishing characters pointed out. Studies are to be made of certain groups of weed seeds which are commonly found in commercial seeds and the effect these weed seeds have on the seed crops of our grasses and forage plants.

In addition to the foregoing, the investigations already in progress will be continued along lines similar to those previously outlined.

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

The work of the Office of Seed and Plant Introduction and Distribution is in charge of Mr. A. J. Pieters, assisted by Mr. David G. Fairchild, agricultural explorer, who is charged specially with foreign explorations and plant introductions.

AGRICULTURAL EXPLORATIONS OF THE YEAR.

The foreign explorations during the year have been restricted by the increasing demands made upon the available funds to care for seeds and plants introduced during former years. Mr. Thomas H. Kearney, of the Office of Vegetable Pathological and Physiological

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Investigations, was sent as explorer to the oases of southern Tunis during the fruiting season of the date palms of that region, and he obtained a remarkable collection of valuable varieties of dates for the Government date plantations in Arizona and California. His is the first expedition undertaken in the height of the fruiting season to any of the great date-growing oases, and his notes and photographs emphasize in a striking way the fact that the date fruit is as varied in form as the apple, and that when the fruiting plantations in the Southwest place their fruit on the market the American public will have to distinguish between the almost round, plum-like Troundja and the long, slender Menakher, or between the dry, hard Bou Hath'm and the soft, delicate Deglet Noor.

In addition to valuable information on date culture secured in the various oases of Tunis, Mr. Kearney made a study of the dry-land oil-producing olives of that country, which are very promising for introduction into California. It is a remarkable fact that the olive varieties hitherto grown in California are chiefly from the semi-humid districts of southern France or Italy, and this is the first attempt to introduce varieties that have become adapted to the arid conditions which prevail in the lands bordering on the Desert of Sahara. Such varieties, it is believed, will prove better suited to the interior dry lands of central and southern California than sorts which, although doing well along the coast, fail to bear well under the trying, almost desert conditions of many of the interior valleys.

The fodder plants of the oases, and especially the fodder cacti of Tunis, Malta, and Sicily, particularly the spineless forms that are cultivated in these regions, were studied by Mr. Kearney, and shipments forwarded to this Office. Arrangements are being made for a special testing garden in California, where will be brought together the edible-fruited forms of this country, Mexico, and the Mediterranean region, as well as the fodder-producing species. This station will be under the supervision of Dr. David Griffiths, the cactus expert of the Bureau.

The strains of resistant alfalfa found by Mr. Kearney in the oases of Tunis and secured by him from Tripoli are now being tested in the arid regions of the Southwest.

Mr. Walter T. Swingle, of the Bureau of Plant Industry, who has been closely associated with the date introduction work since its inception, discovered from the literature of the subject that there existed in the oasis of Siwah, in western Egypt, certain fine varieties of dates, and although the oases had not been visited for a quarter of a century it was determined to send an explorer to obtain these dates. Mr. H. A. Rankin, of Fayum, Egypt, an Englishman whose long residence among the Arabs had made him well acquainted with their language, was commissioned for this work, and he successfully secured, at no little risk and personal discomfort, 113 suckers of the different date varieties from this oasis.

The most famous of all the Persian Gulf dates is the Khalas, cultivated only in the oases of Hassa, some seven days' camel journey into the peninsula of Arabia from the Gulf coast. Rev. S. M. Zwemer, well known from his publications on Arabia, consented to make an expedition to Hassa in search of the Khalas and other date varieties grown there. He secured and shipped a most valuable collection,

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and has reported the presence of immense date plantations in that region, the magnitude of which was hitherto not known.

The importance of producing, by breeding, a variety of potato which would be resistant to various diseases, or be otherwise more vigorous or desirable than the sorts now grown in America, led to the commissioning of Prof. L. R. Jones, of the Vermont Agricultural Experiment Station, to make, for the benefit of the breeders of this country, a trip through Europe for the purpose of securing a collection of all the promising potato varieties of the Continent. His collection of over 90 varieties has been supplemented by importations of 4 interesting varieties of potatoes from the higher altitudes of Ecuador, through Signor Martinez, minister of commerce and agriculture of that Republic, and by the introduction from France of the Uruguayan potato, *Solanum commersonii*, with which French horticulturists have been experimenting.

RICE INTRODUCTIONS.

In response to a call from the rice planters of the Carolinas, whose plantations have been injured by a disease known as "rotten neck," importations of seed rices have been made from Korea, Brazil, India, Java, Formosa, German East Africa, and Ceylon for the purpose of discovering, if possible, a variety of the type of the Carolina Golden which will resist this disease.

MANGO INTRODUCTIONS.

The mango industry in southern Florida, Porto Rico, and Hawaii is attracting more than usual attention, notwithstanding the setback which it suffered in Florida on account of the severe freeze there last winter. The mango collection of this Office, already the largest in the Western Hemisphere, comprising as it does nearly 100 varieties, has been added to by various importations from India. By propagation the stock on hand has been increased, and collections for fruiting trials have been distributed in Florida, Porto Rico, and Hawaii. The freeze of the past winter in Florida, although injuring many of the imported varieties now being propagated there, has not discouraged those interested in the industry, and many varieties inarched at a level with the ground have recovered from the effects of the freeze. The promising character of this fruit tree for culture in the Temperate Zone under glass has been emphasized by the successful experiments in southern Illinois of Mr. Martin L. Benson, who has seedling trees which have borne and ripened most unusual quantities of large fruit.

MANGOSTEEN INTRODUCTIONS.

The problem of finding a better stock for the mangosteen, which will make the cultivation of this most delicious of all tropical fruits a possibility in Porto Rico and Hawaii, has been furthered by the importation from Java, Cochin China, Brazil, and the West Indies of related species which possess more vigorous root systems.

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MISCELLANEOUS INTRODUCTIONS.

Peruvian and East African cottons have been imported to aid in solving the boll-weevil problem. Spawn of the Japanese edible tree mushroom *Shiitake* has been placed in the hands of a mushroom expert. Wardian-case shipments of the *Ramboetan* and *Doekoe*, two promising tropical fruits, have been successfully made from Java. Seeds of the promising new fruit *Feijoa*, plants of which are now growing successfully in southern California, have been secured from Brazil. A collection of canary seed from southern France, Greece, Corfu, and the Canaries is now being tested in California, where it is hoped this grain can be profitably grown.

In addition to those named hundreds of new and interesting plants have reached the Office. Many of these have been presented by the representatives of other governments. Some interesting forms have been secured through the hearty cooperation of our consuls, who have shown a lively interest in this work, or of private individuals, Americans and foreigners, to whom this feature of the Department's activities especially appeals.

PROGRESS WITH IMPORTATIONS.

Of the plants imported in previous years which are being tested all over the country numerous successes have been reported this year.

UDO, THE JAPANESE SALAD PLANT.—The new Japanese salad plant udo has quite unexpectedly proved hardy as far north as Vermont, and there has been forced and served on the table of a connoisseur, who has pronounced it a distinct success—different from any salad plant now known in America. Thousands of plants have been distributed to different parts of the country, and it now remains for the Bureau of Plant Industry to assist in creating a market for this new vegetable in our great cities.

THE CHAYOTE, A PROMISING VEGETABLE.—The chayote, a vegetable of the cucumber family, more palatable than the eggplant, has recently been brought into prominence through the publications of the Department of Agriculture. It is now grown by hundreds of private experimenters in the South, and attempts are being made to call it to the attention of the great hotels in the North which can assist in creating a market for it. The chefs of some of the leading hotels have passed favorable judgment upon it and have placed it on their menus; and it may be predicted that the chayote will gradually win its deserved position among winter vegetables and will be more and more grown in the South and shipped to northern markets.

THE HANNA BARLEY.—The Hanna barley, a brewing barley of prominence in Europe, continues, in California especially, to attract attention by its heavy yields and high quality.

EUROPEAN HOPS.—The European hop varieties imported several years ago, although not proving heavy enough bearers to make them profitable, have emphatically called the attention of the hop growers of the country to the fact that they produce a better quality of hops than do the plants of American origin, and plants of imported va-

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rieties are being experimented with in some of the largest hopyards in the West.

A NEW PEAR STOCK.—The tijocate, a species of Crataegus, which is used in Mexico successfully as a stock for the European pear, was secured last year through Mr. G. Onderdonk, of Nursery, Tex. It is now on trial in the South, where such a stock has long been needed, and indications are quite in its favor.

THE NATAL PINEAPPLE.—The Natal pineapple, a variety from South Africa, presented by Mr. Barbour Lathrop, of Chicago, has fruited at Miami, Fla., and although not considered by experts an ideal variety in all respects, its small size and excellent quality make it available to serve on our tables individually, as oranges are served now.

THE TANAKA LOQUAT.—The Tanaka loquat, noted as the largest variety of this new and promising fruit in Japan, has fulfilled its promise of being one of the largest of its kind yet discovered. It was introduced by Mr. Lathrop in 1902, and a small tree in the Department greenhouse has just borne fruit.

THE PISTACHE NUT INTRODUCTION.—The studies of the new pistache nut industry have been prosecuted with vigor by Mr. Swingle, of the Laboratory of Plant Life History, and in cooperation with this Laboratory several thousand thrifty young seedlings have been propagated in the California Plant Introduction Garden. Scions of large, delicate-flavored varieties were secured by Mr. T. H. Kearney from the slopes of Mount Etna, and these will be used for grafting upon the seedling terebinth and other stocks. Foreign orders are placed for species to be used as stocks, which are reported to exist in China and Persia and which will be hardier and more resistant to alkali than those now employed. There are increasing indications that Mr. Swingle's experiments with this nut will be successful, and that it will form an important dry-land crop where the cultivation of the almond is not now a success.

JAPANESE BAMBOOS.—A large shipment of Japanese timber bamboos was received at the Plant Introduction Garden in California last autumn, and after resting there through the winter these bamboos were distributed to various points in Washington, California, Texas, Louisiana, and Mississippi. At these places small forest plantings were made to learn whether these bamboos would make a growth in this country comparable to that made in Japan. The luxuriant growth of the worthless native bamboo, which forms the "cane brakes" of the South, would seem to indicate that we have along the Mississippi River conditions suited to bamboo culture.

DATE PALM INTRODUCTIONS.—The increasing interest through the Southwest in the date plantings in Arizona and California has made it advisable to expend a large portion of the funds of the Office in securing the best varieties from Arabia and Algeria, and in extending the cooperative arrangements with the California and Arizona experiment stations to care for and propagate these new varieties. In addition to the date gardens which have been maintained heretofore at Mecca, Cal., and at Tempe, Ariz., a new plantation of 10 acres has been established at Yuma, Ariz., in cooperation with the Arizona Experiment Station, and plantings have been made on the

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area controlled by the Reclamation Service at Yuma. The total number of imported palms now reaches over 2,000. A large quantity of seeds has been imported, and these are being grown at the Mecca garden for the purpose of distribution among those interested in the industry. From some of these seedlings new and valuable varieties may originate. Of the palms introduced previously many have produced suckers, and it is expected that a quantity of these suckers will be available for distribution another year. The greatest care will be taken to ascertain as early as possible the quality of the fruit produced by these different varieties in order not to encourage the distribution of varieties which are likely to prove disappointing.

While it is not contemplated that the funds of the Office will be largely drawn upon during the coming year for the introduction of new varieties, since the best ones available have been largely imported, additional shipments will probably be made by individuals interested in the industry who, through the work of the Office, have had their attention called to the opportunities for the importation of date suckers from Algeria, Tunis, and the Persian Gulf region. The interest of planters in the date industry in the Southwest is evidenced by the numerous requests from farmers for importations of small lots of date suckers, and it may be confidently asserted that it has been demonstrated by the Department that imported date palms can be grown and fruited successfully in Arizona and southern California. What the profits of such cultivation will be must depend upon many local matters which it is difficult to foresee.

EUROPEAN GRAPE INVESTIGATIONS.—In cooperation with the Office of Pomological Investigations, and under the direction of Mr. George C. Husmann, nine experimental vineyards located in various portions of California are being maintained.

At the Plant Introduction Garden at Chico are being assembled representatives of all the varieties of grapes introduced by this Office and by the Office of Pomological Investigations, with the object of making this a permanent collection for the purpose of comparison. In addition to these there have already been planted in the Chico garden 66 varieties of resistant stocks to test their relative rooting qualities, which will affect materially their commercial value as graft bearers.

SEEDLESS SIAMESE POMELO.—The seedless Siamese pomelo, which was presented to the Department three years ago by Mr. Barbour Lathrop, through the kindness of one of the Siamese princes, has fruited in the Department greenhouses, and has shown itself to be a perfectly seedless variety, although as yet the fruits have not been brought to perfection. This variety will be distributed the coming season among a few of the pomelo growers of Florida and Porto Rico, and it will be given a careful fruiting test before its general distribution is encouraged.

THE JAPANESE PAPER PLANT.—The Japanese paper plant, from whose bark is manufactured the most delicate Japanese papers so largely introduced into this country, is still under investigation by the Office. Large quantities of seedlings are now being propagated

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in the Plant Introduction Garden, and plans for their distribution are being perfected. The plant has proved itself hardy in the Southern States, and even as far north as Washington has been kept alive out of doors; but the question of its utilization in this country will require several years to determine.

MINOR INTRODUCTIONS.—A large number of minor introductions which have already shown some promise might be enumerated.

The English broad beans, grown so universally in England as a vegetable, collections of which were introduced by this Office into Alaska, have proved remarkably successful in several trials, and are recommended for planting by Prof. C. C. Georgeson, special agent in charge of the Alaska experiment stations.

A promising shade tree for southern Florida, *Pithecolobium dulce*, has been found in one of the introductions of this Office, which, according to Mr. P. H. Rolfs, bids fair to prove one of the most satisfactory trees in that region.

The Japanese horse-radish, or wasabi, has been propagated on a small scale, and is being tested in various suitable localities.

The Kafir plum, a species introduced by Messrs. Lathrop and Fairchild from South Africa, has shown itself of some promise as a shade tree in southern California, and, although it is too early to predict its general use there, its ability to withstand heavy winds and its remarkable growth and development at Riverside make it worthy of attention.

The Hawaiian growers are indebted to this Office for arranging the introduction into Hawaii of the Costa Rican variety of banana, which introduction, in cooperation with the Hawaii Experiment Station, has been successful and will possibly lead to the substitution of this variety for the China banana now principally grown in the south island of the Hawaiian group.

A new and in some respects very interesting fruit called the "Yangtao" (*Actinidia chinensis*) has been received by the Department from the Yangste Valley, through the kindness of Consul-General Wilcox, of Hankau, and young plants are now growing in the Plant Introduction Garden in California. This fruit, described as resembling a gigantic gooseberry in shape and flavor, has been tested by few Europeans, and its possibilities in this country are consequently entirely problematical.

CONGRESSIONAL SEED DISTRIBUTION AND WORK CONNECTED THEREWITH.

The contract for packeting, assembling, and mailing vegetable and flower seeds on Congressional order for the past year was awarded to James L. Drohen, of Dunkirk, N. Y., at $1.19 per thousand packets. This being the lowest bid and Mr. Drohen having demonstrated that his machine, a newly invented one, could satisfactorily packet seed, work was begun at the usual time and the entire distribution was completed by April 22, several days earlier than ever before. Certain weaknesses in the machines developed in the course of the work, however, so that the Department officers in charge devised additional machines both for packeting and for sealing the envelopes. The difficulties encountered and overcome have established the fact that while

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it is more satisfactory to work through a competent contractor there is not the least danger that the Department will ever suffer from a monopoly of any sort in connection with this work, since in case of necessity we can develop our own machines and contract for the work on the basis of using them.

The number of packets of seed distributed, the quantities purchased, and the number of grapevines, strawberry plants, and bulbs distributed are as given below. No trees were distributed the past year.

Kinds of seed and number of packets and packages put up.

Miscellaneous vegetable seeds	packets	32,067,335
Miscellaneous flower seeds	do	3,706,065
Tobacco seed	do	114,190
Cotton seed	1-peck packages	8,665
Cotton seed	½-peck packages	2,880
Lawn-grass seed	½ and ⅓ pound packages	18,000
Miscellaneous seeds	packets	60,000
Total number of packets and packages		35,977,135

At the close of the work, seeds in packet and in bulk were left on hand as shown below:

Seed in packets and packages remaining on hand at the close of the distribution.

Vegetable seeds	packets	20,183
Flower seeds	do	5,750
Tobacco seed	do	23,794
Cotton seed	packages	650

Bulk seed remaining on hand at the close of the distribution.

	Pounds.
Miscellaneous vegetable seeds	104,000
Miscellaneous flower seeds	184
Tobacco seed	7
Cotton seed	9,000
Grain grown at a high altitude	5,500
Miscellaneous grain, forage crop, and other seeds (estimated)	50,000
Total	168,691

The vines, plants, and bulbs distributed were selected by the Botanist in Charge after consultation with the various experts in the Department. In the bulbs a change was made this year from fall-planted to spring-planted varieties. This was done partly to add variety to the sorts to be popularized and partly in order to use American-grown bulbs, the two sorts selected, gladiolus and tuberose, being distinctly American bulbs, by reason of the very large production of these sorts by American growers. With the exception of the extreme southern sections, to which only gladioluses were sent, each box contained ten tuberose and ten gladiolus bulbs.

The numbers of vines, plants, and bulbs distributed were as follows:

Grapevines		24,675
Strawberry plants		97,000
Bulbs:		
Gladiolus	134,000	
Tuberose	98,400	
		232,400

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The total appropriation for the fiscal year 1905 was $290,000, which was expended as shown below:

Expenditures for the purchase and distribution of seed.

Salaries:		
In Washington		$62,471.11
Outside of city		8,608.33
Traveling expenses		7,064.99
Miscellaneous authorizations		4,359.20
Contract for assembling and mailing seeds		41,924.49
Purchase of seeds and plants:		
Vegetable and flower seeds	$66,177.09	
Tobacco seed	917.53	
Cotton seed	3,360.08	
Sugar-beet seed	2,116.32	
Lawn-grass seed	1,171.45	
Miscellaneous seeds	6,490.41	
Miscellaneous plants	3,864.12	
Trees (orange), new creations	1,015.35	
Bulbs	3,264.20	
Cooperative work on seed-testing experiments	1,847.31	
Strawberry plants and grapevines	756.00	
		90,979.86
Alterations to seed warehouse		6,798.00
Telegrams		117.38
Freight, express, and hauling		4,515.68
Gas and electric light		87.62
Telephone rental		27.15
Fuel		2,458.62
Miscellaneous expenses		15,961.73
Total (domestic)		245,374.16

Expenditures from the allotment of $40,000 for the purchase and distribution of foreign seeds and plants.

Salaries		$10,598.06
Miscellaneous seeds and plants		4,362.89
Miscellaneous purchases		157.62
Letters of authorization		12,303.25
Grape work		2,882.51
Introductions:		
Chico plant garden	$7,000.00	
Date palms	789.05	
Miscellaneous introductions	1,149.65	
		8,938.70
Total (foreign)		39,243.03
Total expenditure on domestic seeds		245,374.16
Total expenditure on foreign seeds		39,243.03
Total		284,617.19
Total appropriation		290,000.00
Total expenditure to date		284,617.19
Balance		5,382.81

A large amount of the money accounted for under "letters of authorization" on the foreign seeds fund was expended in the purchase of date palms and their introduction; but since the accounts have not all been received a more detailed statement is not possible at this time.

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The net balance shown will be somewhat increased by refunds on outstanding contracts and authorizations, but nearly all this balance will be required to settle freight bills, which are usually slow in coming in.

SPECIAL DISTRIBUTION OF SEEDS AND BULBS.

In order to meet the demand from competent cooperators for really new varieties, certain limited quantities of specially selected seeds and bulbs were purchased and distributed as follows:

	Pounds.
Vegetable seeds	617
Bulbs	2,000

SEEDS SENT TO ALASKA AND ELSEWHERE.

It has for some time been the practice to send seeds of desirable varieties of vegetables to Alaska to be distributed through Prof. C. C. Georgeson, of the Alaska experiment stations. Reports from time to time received indicate that such seeds often do a great deal of good, one case being reported where a small mining community was saved from the ravages of scurvy by vegetables grown from the seeds sent by the Department. The communities are so far apart and communication is so difficult that the Department seeds are about the only ones planted. Frequent applications for seed have been received from Army commands on their way to the Philippine Islands, and all such have been liberally supplied. The Department feels that while little is known in regard to the varieties of vegetables adapted to those regions, a good opportunity is afforded by the company gardens to test American vegetables under tropical conditions. Seeds have also been sent to Panama, so that fresh vegetables might be raised for the Americans employed there.

COTTON SEED.

The varieties of cotton seed purchased at the suggestion of Dr. H. J. Webber, and with each package of which, as usual, a descriptive circular was inclosed, were as follows:

	Bushels.
Hagaman	700
Southern Hope	500
Strickland	300
Texas Wood	100
Culpepper	300
Triumph	300
Centerville	120
Total	2,320

SUGAR-BEET SEED.

The sugar-beet seed purchased was all American grown, and was nearly all distributed in lots of 100 pounds to factories and growers agreeing to make a special test and report. Largely as a result of our distribution during the previous year, the good qualities of American beet seed were recognized last year by factories, and the grower of this seed was unable to fill all the orders he received. The total quantity purchased and distributed was 18,500 pounds.

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LAWN-GRASS SEED.

Two kinds of lawn-grass seed were distributed during the past year. To the Gulf States and to the States and Territories in the Southwest was sent seed of Bermuda grass, which is undoubtedly the best lawn grass for hot and dry situations. To the other States a mixture of redtop, Kentucky bluegrass, and white clover was sent. The total number of packages distributed was 20,000.

TOBACCO SEED.

The plan of distributing tobacco seed during the past year remained the same as during the previous year. The number of packages distributed and cost are given in previous tables.

FORAGE-CROP SEED.

It was hoped at the beginning of the year that funds would be available to employ an expert to push the distribution of forage-crop seeds, but this appeared to be impracticable. The plan adopted during 1904 was therefore adhered to, and correspondence was entered into with every applicant, so that seeds best adapted to his needs might be sent. In this way the several hundred requests received from Senators and Representatives in Congress were satisfactorily met.

SUGAR-BEET SEED GROWING.

THE PRODUCTION OF HIGH-GRADE STRAINS OF SEED.—The work of producing high-grade sugar-beet seed has progressed very satisfactorily, and we are awaiting with considerable interest the analyses of the roots grown from the first seed produced by the Department from chemically analyzed and recorded roots. This seed was grown at Geneva, N. Y., and at Fairfield, Wash., last fall, and was sown at those places this spring. The prospects at present are very encouraging for a good crop of roots. More than 2 acres have been planted with this seed at Geneva and 6 acres at Fairfield. No seed grown from roots testing under 18 per cent was planted at either place. Such seed as was raised by the Department from roots testing 16 and 17 per cent was placed with farmers in the neighborhood of Geneva and Fairfield, to be used in growing commercial crops of roots, which, however, are grown in the same field as crops from seed furnished by their respective factories, and this will enable us to definitely determine their relative values.

The roots raised at Fairfield gave the following results:

Roots tested.	Sugar in juice.	Seed produced.
Number.	*Per cent.*	*Pounds.*
5	23	2¼
35	22	25
55	20	39
54	19	38
36	18	36

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Individually analyzed roots varying in sugar content from 18 to 24 per cent are now growing at each of the five stations, the greatest number being at Fairfield, where the following analyses were obtained:

9 roots tested 24 per cent sugar in juice.
50 roots tested 23 per cent sugar in juice.
100 roots tested 22 per cent sugar in juice.
191 roots tested 21 per cent sugar in juice.
187 roots tested 20 per cent sugar in juice.

Several hundred roots tested 18 and 19 per cent.

Seed has been sown at each of the five stations for the production of "mother" roots with which to carry on the work another year. The seed used for this purpose was that which has proved in our several years' work as of the best quality, namely, Original Kleinwanzlebener, from Klein Wanzleben Sugar Company, Klein Wanzleben, Germany; Schreiber's Specialität, from G. Schreiber & Sons, Nordhausen, Germany; and Kleinwanzlebener, from E. H. Morrison, Fairfield, Wash.

COMPARATIVE MERITS OF AMERICAN AND FOREIGN GROWN SEED.—Besides detailed notes and records, tables similar to the following were made at each station where the work was carried on. The table given below has been compiled from those from the five stations:

Results of variety tests of sugar-beet seed, season of 1904.

Variety.	Grower.	Sugar in juice.	Sugar in beet.	Coefficient of purity.	Yield per acre.
		Per cent.	*Per cent.*	*Per cent.*	*Tons.*
Kleinwanzlebener	Utah Sugar Co., Lehi, Utah	19.7	17.6	87.2	10.93
Do	E. H. Morrison, Fairfield, Wash.	19.5	16.6	87.9	13.17
Do	American Beet Sugar Co., Grand Island, Nebr.	19.9	16.5	86.6	10.44
Do	C. C. Morse & Co., Santa Clara, Cal.	17.7	15.0	83.7	11.53
Do	H. C. & J. B. Agnew & Co., Agnew, Cal.	19.0	15.7	85.1	11.49
Original Kleinwanzlebener.	Klein Wanzleben Sugar Co., Klein Wanzleben, Germany.	19.8	16.8	86.6	9.92
Elite Kleinwanzlebener	Otto Bruenstedt & Co., Schladen-am-Hartz, Germany.	19.2	16.8	86.1	10.50
Do	Dippe Bros., Quedlinburg, Germany.	20.2	17.1	86.2	10.79
Do	C. Braune & Co., Biendorf, Germany.	19.1	15.8	84.8	11.64
Kleinwanzlebener	Henry Mette & Co., Quedlinburg, Germany.	18.2	16.1	86.5	11.29
Do	F. Heine & Co., Hadmersleben, Germany.	19.8	17.0	86.0	10.43
Do	Kulm & Co., Naarden, The Netherlands.	19.6	17.0	86.6	10.49
Do	Otto Hoerning & Co., Eisleben, Germany.	18.1	15.9	85.5	11.20
Aderstadt	Knauer & Co., Grobers, Germany.	18.3	15.9	84.7	9.95
Jaensch Victrix	Gustav Jaensch & Co., Ascherleben, Germany.	18.5	16.0	86.6	9.71
Schreiber's Specialität	G. Schreiber & Sons, Nordhausen, Germany.	20.6	16.9	87.3	10.72
Knauer's Mangold	M. Knauer & Co., Grobers, Germany.	18.0	15.2	85.4	10.32
Average of all samples.		19.14	16.36	86.05	10.85

While the table shows that the seed raised by the Utah Sugar Company was 1 per cent higher in "sugar in beet" than that raised by

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the other American growers, the "sugar in juice" and "coefficient of purity" are practically the same and it is very doubtful whether the high percentage of "sugar in beet" will be maintained another year.

The most striking feature of the table is the tonnage recorded for the Washington-grown seed, a most important factor, it being not only much greater than the average, but 1½ tons greater than any other variety.

While such a table made from a single year's work is not at all conclusive, it is valuable as showing the result from five stations, rather than from a single station.

COMMERCIAL TEST OF AMERICAN AND FOREIGN GROWN SEED.—Last year the Department of Agriculture secured some 4,000 pounds of California-grown and 11,000 pounds of Washington-grown Kleinwanzlebener sugar-beet seed, all of which was distributed throughout the sugar-beet growing sections of the United States for the purpose of comparing the results obtained under ordinary cultural conditions from this American-grown seed and those secured by the use of the seed furnished to farmers by the factories.

While some of this seed was sent directly to the factories, the greater part was placed with farmers within hauling distance of the factories, who had been recommended to the Department by the factory agriculturists as being the most painstaking and best suited for this line of work. In placing this seed each farmer was interviewed, when the exact nature of the work was explained to him and the requirements in preparing the soil and in planting and caring for the crop were discussed.

As a rule, seed was only supplied to farmers who were planting at least five acres of beets and who had available fields of at least this extent which were uniform in texture and physical properties and had been cropped and manured in the same manner for a number of years. Occasional exceptions were made in cases where farmers planted but two or three acres, providing they were especially recommended by their respective factory managers. In every case the available land was measured and staked off, one-half to be sown with seed furnished by the Department and the remainder with seed furnished by the factory. With few exceptions no individual was given more than enough seed to plant five acres. Before harvest time each farmer was again visited and a personal inspection was made of his field. Where it was found that both lots of seed had not been sown and cared for in such a manner as to insure a good comparative test, note was made of the fact and later either his reports were eliminated or corrected by discarding the data from the objectionable portions of the field.

Each experimenter was sent two blanks for making his report, which included questions regarding germination, sugar content, purity, and yield. The Bureau was unusually fortunate in obtaining these reports, as but a very small percentage was not returned, while very few were made out so carelessly that their accuracy could be questioned.

A review of these reports shows that 73 per cent of those planting the Washington-grown seed and 64 per cent of those planting the California-grown seed found it to be of quicker, stronger, and

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healthier germination, while none found it inferior to the seed furnished by the factories in these respects. While the returns have not all been received, those from 561 acres show that the sugar content of beets from the Washington-grown seed was 15.4 per cent, and that of beets from California-grown 14.4 per cent, as against 14.9 per cent for beets from the factory seed; and a yield of 10.7 tons for the Washington seed, 9 tons for the California seed, and 9.1 tons for the factory seed.

THE EFFECTS OF VARIOUS QUANTITIES OF WATER UPON THE QUALITY OF SEED.—In addition to the work previously described the Bureau of Plant Industry is cooperating with the Utah Agricultural Experiment Station at Logan, Utah, in carrying on experiments to determine the effect, if any, of various quantities of water applied at different times for irrigation purposes upon the permanent qualities imparted to seed.

This work, even though in its infancy, shows some remarkable preliminary results, but it will require several years to definitely determine their value.

GROWING SPECIAL COTTON SEED.

Continuing the policy of cooperating with the other offices in the Bureau a contract was made during the past year for the growing of 37 acres of cotton, as follows:

(1) Eight acres of a selected hybrid, Sea Island × Ashmouni (Egyptian.)

(2) Eight acres of selected strains of Ashmouni and Mit Afifi (Egyptian cottons.)

These three varieties were grown at the request of Dr. H. J. Webber. No seed was saved for distribution, as the result of the season's work confirmed the decision of last year that these varieties, while valuable, require too long a season for any but the most southern parts of our cotton section.

(3) Six and one-half acres of Centerville Sea Island cotton.

This is a new wilt-resistant strain more productive than Rivers cotton and with more widely open bolls but not quite as long a staple. About 100 bushels of this seed were available for distribution in the spring of 1905.

(4) Six acres of Jackson limbless wilt-resistant Upland cotton.

This is a selection that has been for some time under observation by Mr. W. A. Orton, a pathologist of the Bureau. It is said to be unusually storm resistant and nearly or quite resistant to wilt. About 25 bushels of seed were secured for distribution.

(5) Three acres of Sea Island cotton.

Several varieties were tested on the mainland under the supervision of Mr. W. A. Orton, in order to find those best adapted to such conditions. Mr. Orton reported at the close of the season that the select varieties proved much superior to the common sorts.

(6) Six acres of Upland wilt-resistant varieties.

Tests were made of several strains to perfect their wilt resistance and select the best sorts. The contract with the growers included a guaranty, which, however, it was not necessary to meet, as the receipts from the sale of lint and seed aggregated more than the guaranteed amount in every case.

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The work on wilt-resistant varieties was in charge of Mr. W. A. Orton.

BULB GROWING.

In order to carry on detailed experiments on the culture of bulbs in the East, a portion of the Potomac Flats having a sandy loam soil was selected and more than a thousand varieties of bulbous plants were put in. These were chiefly narcissuses, tulips, and hyacinths. A small additional supply of bulbs was sent to the bulb growers with whom the Department is cooperating, and visits of inspection were made by the Botanist in Charge and by Mr. George W. Oliver. Agreements have now been made with certain of the bulb growers for carrying on experimental work, and we shall soon be able to secure exact data without undertaking to establish special bulb gardens.

BERMUDA LILY BULB GROWING.

The outlook for the commercial production of lily bulbs was found to be even beyond expectation, splendid bulbs being produced in California from seed raised by Mr. George W. Oliver in the Department greenhouses. Mr. Oliver says in regard to this work:

During the summer of 1904 a considerable quantity of home-grown lily seed was distributed to growers on the Pacific coast. This seed germinated well in the open and the seedlings stood the winter temperature successfully. Although the seedlings were not planted in the fields the progress made by them in the seed beds showed that this might have been done to advantage. Bulbs of the Bermuda lily which had been raised from seed in the greenhouses of the Department in 1904 were also distributed, and the growth made from these shows that some parts of California are even more favorable to the growth of Easter lily bulbs than Bermuda. Some of the plants within two years from seed had no less than thirty-six blooms to a stalk, with no trace of disease on the foliage. The scales from these bulbs will be planted this season to ascertain how far this method of propagation will succeed under the conditions existing on the Pacific coast.

CEREAL WORK.

The cereal work has again been in charge of Mr. M. A. Carleton, Cerealist, who has prepared the following report:

The principal work with introduced grains during the past year, from which important results have been obtained, can best be described under the following topics:

1. Kharkof winter wheat.
2. Winter varieties of oats and barleys.
3. Sixty-Day oat.
4. Further work with durum wheat.
5. Grains for the southwestern desert.
6. Galgalos wheat.
7. Further experiments with rye.

(1) KHARKOF WINTER WHEAT.—For several years experimental trials have been made with different varieties of the hardiest introduced Russian winter wheats in order to be able, if possible, to largely extend the winter-wheat area northward as well as westward. It can now be concluded definitely that by far the best of all of these varieties for resistance to both drought and cold is the Kharkof. All of these varieties are similar to the Turkey or Crimean variety, which is well known in Kansas. Experiments with the Kharkof

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wheat have continued to give excellent results, this variety yielding at the branch experiment station, Hays, Kans., during the season of 1904, 17½ bushels per acre, which is really a very fair crop. The highest yield of any of the other winter wheats was a little more than 11 bushels per acre, and the average yield of all other winter wheats at the same station was far below the latter figure. At the same time the wheat crops on various farms in the vicinity amounted to little or nothing. In western and extreme northern Nebraska, where the Kharkof wheat appears to yield fairly well every year, no other known variety can be depended upon. The Kharkof variety has succeeded as a winter wheat at a number of different points in eastern and central South Dakota, and has given a much better yield than ordinary spring wheat on the same farm as far north as Lisbon, N. Dak. Further acclimation and selection will probably adapt it for cultivation throughout a large portion of eastern North Dakota. In addition to the hardiness of this wheat it has had an excellent opportunity during the past season to show its value in escaping attacks of rust because of its early maturity. In North Dakota and South Dakota, wherever it was grown, it was very little, if at all, affected by rust, while the ordinary spring wheat was badly shriveled and sometimes destroyed by rust.

(2) WINTER VARIETIES OF OATS AND BARLEYS.—The Hankau winter hull-less barley and the Black Arabian barley have both continued to give good results in resisting the cold of winter, and the aim is now to increase the seed of these as rapidly as possible. At present there is none for distribution. At the same time the hardiness of several other winter barleys has been noted; indeed, there are at present no more interesting results being obtained with introduced grains than in the cases of these winter barleys. In the experiments conducted near Dallas, Tex., it has been found that the Hankau variety is also very early in maturing, which, for a winter sort, is a matter of great importance for the South. This barley and another, also from China (S. P. I. 6601), have given such excellent results as winter varieties and because of their earliness that the success with these varieties alone has amply repaid all the time and expense given to the experiments at Dallas for several years. They are at present known to be sufficiently hardy for fall seeding as far north as Oklahoma.

(3) SIXTY-DAY OAT.—Each year's work shows more and more the value of the very early variety of oat known as the Sixty-Day, introduced several years ago from southwest Russia. Its earliness has always given it an advantage in escaping the attacks of rust, chinch bugs, and other foes of the oat crop. Results all over the Northwest were still more striking in the season of 1904. In the cooperative experiments in South Dakota, at Brookings, during the past season, the Sixty-Day oat yielded 84½ bushels per acre, while the best of a number of other varieties yielded 51.8 bushels in comparison. As several other varieties included in these experiments are known to be more drought resistant and therefore ordinarily better adapted to semiarid regions, it is evident that the Sixty-Day oat in this case owed its superiority to its earliness in maturity, enabling it to escape the severe attack of rust which occurred during the unusually wet

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season. Moreover, this variety is useful in certain dry districts, not because of its resistance to drought, but because it ripens before the drought reaches its severe stage, while other varieties mature so late as to catch the full effects of the drought at the most critical period—during the time of the formation of the grain. This appears to be particularly true in Utah, where the Sixty-Day oat has given very successful results for several years in succession, its average yield for these years being greater than that of any other among twelve or fifteen varieties.

(4) FURTHER WORK WITH DURUM WHEAT.—During the past season considerable work in the further demonstration of the superiority of the durum wheats for dry districts has been carried on in localities where little or nothing in this line had been done before. The greater part of this work and that which has given the most interesting results has been on the high plains of the Southwest and northward to the Kansas-Colorado border region. Some work was also begun in the Sacramento and San Joaquin valleys of California. The results in the southwestern plains have been particularly important and have induced farmers to give much more attention to the cultivation of crops in that region. Two years' work, and in a few cases three years' work, have now been given to these experiments, and there is little, if any, doubt of the success in grain growing in that country when proper methods of cultivation are employed. In a large portion of the area including the Texas Panhandle and Beaver County, Okla., considerably west of the 100th meridian, ordinary grains will not usually succeed, but it has been noted that even in a better season than usual, when ordinary winter wheat will produce a fair crop, the durum wheat, when grown by the side of it, invariably yields 5 to 15 bushels per acre in excess of the other wheat.

(5) GRAINS FOR THE SOUTHWESTERN DESERT.—After further experiments the Beldi and Telli drought-resistant barleys continue to give the best results in Arizona and southern California. The grain is of fine appearance and the yield per acre is good in every case. The Maraouani durum wheat also continues successful in this region and can now probably be considered the best durum variety for the southwestern deserts. The Fretes wheat, one of the common varieties introduced from Algeria, has given good results for several seasons, and may also be numbered among those varieties well adapted to the Southwest. On further acclimation it appears to become better each year. Practically the same thing may be said of the Chul variety, introduced from Turkestan, and of the common wheats these two may be considered without question the only varieties well adapted to that region as so far known.

(6) GALGALOS WHEAT.—One of the most interesting introductions of cereals was made from trans-Caucasia two years ago. It is the Galgalos wheat and possesses a rather remarkable combination of extreme qualities. The variety is extremely drought resistant, but is also very winter-hardy, which two qualities seldom are found together in an extreme degree in the same variety. It is a beardless variety of the common wheat group, and yet appears to be as fully resistant to drought as the best of the durum wheats in this respect. In addition to its combination of these four characteristics it now appears to be also rather early in ripening, at least earlier than the

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ordinary hardy winter wheats of this country. The quality of the grain is yet to be determined, no tests of this kind having been made. At present there is no seed for distribution, but an effort is being made to increase the supply as rapidly as possible.

(7) FURTHER EXPERIMENTS WITH RYE.—In the report of the preceding year the good qualities of the Abruzzes rye were mentioned. Further experiments with this variety confirm the statements of last year and indicate that it will be one of our best varieties for general purposes in all the region south of the fortieth parallel. Though a spring rye it is rapidly becoming acclimated for fall seeding in Kansas and at other points as far north. It makes a rank growth, and after being pastured will still furnish a considerable quantity of hay when cut green, or, if allowed to ripen, will produce a good crop of grain of large-sized kernels. Sown as a spring rye this variety gives good results in northern latitudes and at high elevations because of its quick growth.

The Ivanov variety also continues to give good results, being adapted to northern latitudes for fall seeding. It is extremely hardy and usually grows taller than other varieties.

ALFALFAS.

TURKESTAN ALFALFA.—Owing to transportation difficulties the 2,000 pounds of seed of Turkestan alfalfa ordered during the spring of 1905 did not arrive until too late to be used this year, and no active extension of the work was possible. Seed was received from a few persons having contracts for growing Turkestan seed from our previous importation, and the reports received continue to point to this strain as one especially useful for the drier portions of the alfalfa section.

GRIMM ALFALFA.—For some years alfalfa has been successfully grown in parts of Minnesota, and this strain has come to be known as Grimm alfalfa. A description and history of the strain are given in Press Bulletin No. 20 of the Minnesota Agricultural Experiment Station. The seed production of this hardy strain in Minnesota was, however, very poor, and in consequence 600 pounds of seed were purchased and divided, one-half being placed with a reliable farmer in Montana and the remainder in Nebraska, in order to secure an abundance of this seed.

SPECIAL COMPARATIVE TESTS OF ALFALFA.—Observations made during an inspection trip in the Northwest during the summer of 1904 suggested the value of a comprehensive test of alfalfa seed produced in different parts of the United States, the object of the test being to determine, if possible, whether any relation existed between the climate and soil conditions under which the seed was produced and the value of the seed for use in the various parts of the United States. Arrangements were therefore made with the Laboratory of Plant Life History of the Office of Vegetable Pathological and Physiological Investigations looking to such a comprehensive test. This Office is interested from a plant-introduction standpoint in the question whether such relationship exists; whether, for example, farmers in Minnesota and the Dakotas should use Montana or Utah grown seed, and whether those in the drier portions of the West should use

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seed from irrigated or from nonirrigated fields. The causes of such phenomena, if found to exist, will be determined. In accordance with this general plan Mr. Charles J. Brand was put in charge of the work, and he arranged for plantings of seed of 23 varieties, those from the United States being selected from Montana, Nebraska, Kansas, Utah, Texas, Minnesota, and New York, the others being imported from Europe, Turkestan, Peru, and Arabia. At each of the main stations all the varieties of which sufficient seed could be obtained were planted in acre plats. Nine cooperators in the States of North Dakota, Texas, Nebraska, Utah, Oregon, and New York received seed of practically the entire set in acre quantities, while 13 cooperators received smaller quantities or less complete sets. The aggregate of all the plantings covers about 150 acres.

ARABIAN ALFALFA.—More seed of Arabian alfalfa, which was reported last year as giving promise of usefulness, was received and sent to California for testing. Arrangements were also made for saving the seed for future distribution. At the Chico tract of the southern California substation, under the direction of Prof. A. V. Stubenrauch, the plats of Arabian alfalfa were cut five times, while those of the common alfalfa yielded only four cuttings. The average yield per acre of two plats of Arabian was 16,533 pounds, against 12,069 pounds of the common alfalfa.

BERSEEM.

The cooperative work with the Arizona Experiment Station on the use of berseem on overflow lands of the Colorado River did not yield positive results, but at the Department date palm garden at Mecca, Cal., this clover proved to be the best of all the cover crops tried, especially where the inoculation of the seed with nitrogen gathering bacteria was a pronounced success. Certain trials on the rice lands of the South also give promise that berseem will prove a valuable crop there in rotation with rice.

DOLICHOS ATROPURPUREUS: A NEW DROUGHT-RESISTANT LEGUME.

Several years ago, among other samples of seed received from Naples, Italy, was that of a Dolichos under the above name. The exact identity of this plant has not yet been established, but a very reliable correspondent in Kansas writes that the variety gives promise of being of the greatest possible value. He says:

> There is very little doubt that this is an extremely valuable acquisition. It matures its first crop of beans in August; therefore it could be produced at least 200 miles north of here. Although it matures two crops of beans here in south central Kansas, the vines remain perfectly green until heavy frosts. It requires a heavier frost to kill the vines of this Italian variety than will kill the common varieties. It makes the finest hay I ever saw. Stock eat it all. There is not a particle of waste, as in feeding other soy beans.

CASSAVA.

Special attention was paid this year to determining the content of starch and of hydrocyanic acid in the several varieties of cassava imported. This work was done in cooperation with the Bureau of Chemistry, Dr. C. C. Moore, of that Bureau, conducting the analyses,

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The field expenses were paid jointly from the fund for grass and forage plant investigations and from that for the purchase and distribution of valuable seeds. It was found that the starch content in the dry substance varies from 50 to 81 per cent, and the hydrocyanic acid content from 0.0005 to 0.018 per cent. Many of the varieties with high starch content have, therefore, too much of the poisonous acid to be useful in their natural state.

JAPANESE MATTING RUSH.

In order to push the introduction of the culture of Japanese matting rush, a special garden was established at Cat Island, near Georgetown, S. C. The site selected is typical of much of the rice land now being abandoned by the rice growers, and it is hoped that the matting-rush culture may be successfully established as a partial substitute for rice culture. Several thousand seedlings have been raised in the Department greenhouse and sent to Cat Island, while a number of roots of California rushes have also been sent there. Besides the rush, other cultures are also being tested.

FLAX.

During the past year the tests of introduced varieties of flax have been continued, principally at the North Dakota Experiment Station. Most of these have been tested in small beds for the purpose of making selections either to gain resistance to wilt or to rust. Several varieties have already shown considerable merit on sick land. Eight of the varieties are said to be especially promising. Unfortunately two of the varieties that proved to be unusually good as seed producers and which Professor Bolley states far exceed in quality of seed any Minnesota or North Dakota grown seed are not at all wilt resistant, and until this quality can be bred into them they will have to be grown on virgin soil. Professor Bolley says further:

> It may be said in general that our experience with these samples which we have brought over indicates that we shall be able by selection methods to procure from various of them strains of seed which are wilt resistant, others which are more or less rustproof, and some especially fine yielders of seed and fiber, according to the line of selection. When we have decided the ones of special merit, they will be increased and farmed out, so as to procure the seed in large quantities.

TESTS OF SEEDS USED IN THE CONGRESSIONAL DISTRIBUTION.

Besides carrying on trials to determine and describe varietal types and ascertain the practical value of different varieties, samples of the seed used for free distribution were planted in comparison with samples of like varieties from the best seedsmen. Three hundred and eighty-two separate lots of seed were tested, all of which had been used or were to be used in the Congressional distribution, and these lots were found to be just as good as those sold by the better class of seedsmen.

DEMONSTRATION FARMS.

The work on the three demonstration farms, one at San Antonio, Tex., one at North Galveston, Tex., and one at De Quincy, La., was

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continued on the same lines as heretofore. The principal work at all of these places has been that of getting ready, and this has required not only all the funds available but also time.

At the San Antonio farm a number of seedling peach and apricot trees have been planted. These trees were grown from seed collected in Mexico, and it is hoped that some of the varieties will, when fruited, prove to be acceptable additions to the fruits for that section. A gardener has also been assigned to San Antonio for the purpose of caring for the tests of special introductions.

At North Galveston, rice, berseem, and alfalfa have been grown, the last with encouraging success. The berseem was a decided success the past year, nearly 2 tons of cured hay being harvested per acre for the first cutting.

VARIETY TESTS OF VEGETABLES.

The test of vegetable varieties, as carried on by Mr. W. W. Tracy, sr., is mainly directed toward the standardizing of American varieties. In order that seedsmen may furnish varieties of such exact type and behavior as modern gardening conditions require, it is necessary that standard types be made out and adopted for all varieties. This Office is endeavoring to bring about uniformity among seedsmen in this respect by obtaining samples from all the principal seed houses in order to determine the really distinct sorts and settle upon the most generally recognized or desirable type of all distinct varieties. These will be fully described as soon as the work on each vegetable is completed, and the history, horticultural status, and practical value of every variety will be definitely stated.

This Office has continued to collect, as heretofore, all the catalogues of seedsmen in the country and to make note on its card index of all claims made for the different sorts, as well as to preserve a complete history of each variety. The list of catalogues now numbers over 2,000 copies.

There were introduced last year by American seedsmen no less than 75 so-called new varieties of vegetables. The more important of these introductions were tested on our grounds, but there were not more than ten really distinct and valuable introductions, the remainder of the so-called new sorts being either strains or kinds already listed by seedsmen under other names. It is plain that so long as seedsmen or experimenters have no standard for variety types, only the few well informed can say whether any apparently new plant is a distinct variety or simply a stray plant of some kind already listed by seedsmen. More varieties are renamed because of this lack of information than from any other cause, while our investigations have also shown that once familiar sorts are sometimes introduced as new kinds although they had been in use and dropped from the seed trade as undesirable once or even several times before.

American seedsmen now catalogue of each of the important vegetables from 50 to 500 so-called varieties. Such a list is plainly too large for any seedsman to handle and the substitutions which result are very numerous. It is practically impossible for a seed grower to care for so large a number of sorts and at the same time maintain a high standard of purity, while gardeners are bewildered by so many

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descriptions, especially when they are contradictory, biased, or imperfect.

To carry variety testing along the lines mentioned above, 1,486 samples were planted last season in eight different sections of the country, viz, at Washington, D. C., Brookings, S. Dak., Orono, Me., Columbia, Mo., Mattituck and Floral Park on Long Island, and at Greenwich and Leroy, N. Y. It is found that beets, radishes, corn, onions, cucumbers, and tomatoes are the vegetables whose varieties are the most mixed, while melons, pumpkins, squash, beans, and lettuce are more pure than other vegetables. Besides inspecting the trials at the above places, Mr. Tracy and his assistants have also visited many of the different experiment stations and seedsmen's trial grounds.

SWEET-CORN STUDIES.

The effect of the climatic and soil conditions under which the seed is grown on the character of the product obtained from it is of great importance, particularly to seedsmen and canners, and the experiments with seed corn to gain light on this question, which were undertaken by the Department last season, are to continue the present year. In these experiments samples of the same lot of seed were planted in Missouri, on Nebraska uplands and river bottoms, and in Minnesota, Connecticut, and Virginia. The product of this identical seed produced in all these places was assembled at Washington and careful notes were made of its external characteristics and chemical composition, and then selected lots of the seed were returned to the places where grown to be again planted and the product assembled and its characteristics noted and recorded. It is proposed to continue this work for at least five seasons, thus obtaining the accumulated effect of the local conditions on the character of the grain produced. The seed from these various locations is also planted side by side at several different experiment stations to observe the effect on the character of the growing plant, as well as on the appearance and character of the seed.

CARD INDEX OF DEALERS, SEEDSMEN, GROWERS, AND SPECIALIZERS.

During the present year there has been compiled an index of 8,000 cards giving the names and addresses of dealers, seedsmen, growers, and specializers in seeds, grains, bulbs, and plants, together with remarks regarding their reliability and such miscellaneous information as it has been possible to obtain.

Each person or firm is indexed in three ways: (1) Alphabetically; (2) geographically (by States and Territories); and (3) under the specialties handled. The triplicate cards enable one about to visit any State or section to ascertain what growers, dealers, etc., in that locality are interested in any specialty. Heretofore, as far as known, there have been no such records available by which one could easily secure the names and addresses of dealers in and growers of any special commodity such as salsify, brome grass, hybridized petunias, etc. Additions will be made to this index from time to time as new data are obtained.

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PLANS FOR THE FUTURE.

NORTH CHINESE EXPLORATION FOR THE COMING YEAR.—For the coming year it is intended to confine the exploration work to the region of northern Asia, and especially northern China, possibly including Manchuria and Korea. Mr. Frank N. Meyer, who has a fair knowledge of the Chinese plants already introduced into this country, will be sent as an agricultural explorer to that region. He is a trained gardener and is capable of packing and shipping such seeds and plants of economic importance as may be found in that region. In view of the similarity of the climate of northern China to that of eastern America and from the small amount of agricultural work which has been done there, it is confidently expected that this explorer will bring back many things of interest to the nurserymen, florists, fruit growers, and farmers of our Northern States.

Among the promising plants which Mr. Meyer may be expected to secure are the north China persimmon, which will probably prove hardy in the New England States; new and interesting varieties of the Chinese cling peach, from single seed importations of which some of our best strains of American peaches have originated; hardy types of the English walnut; new strains of the so-called "Japanese chestnut;" hardy stocks for the edible-nutted pistache; new types of hardy apricots; cold and drought resistant varieties of grains; and numerous interesting ornamental trees and shrubs. Professor Sargent, of the Arnold Arboretum, who has been studying the adaptability of the Japanese ornamentals and fruit trees to the conditions of the Atlantic States, and who has experimented with many north China plants, has come to the conclusion that many of the Japanese types of trees and shrubs which do not prove hardy on the Atlantic coast are represented by close relatives in China, and that these latter are in all probability much hardier, and when introduced will prove better suited to our severe conditions than their Japanese relatives. It is this fact, confirmed by the nurserymen of the country, which makes the exploration of northern China a matter of the utmost importance to American agriculturists and horticulturists.

MISCELLANEOUS INTRODUCTIONS.—The grape vineyards and date orchards will be maintained and added to, and the testing of the various introductions mentioned as being under way will be continued. It is expected that many new things will be secured by our explorer in China, and these will be properly propagated, tested, and distributed.

VARIETY TESTS OF VEGETABLES.—During the present season 1,680 samples are being grown in eight different sections—Washington, D. C., Chico, Cal., Auburn, Ala., Lincoln, Nebr., Wooster, Ohio, Columbia, Mo., Orono, Me., Ithaca, N. Y., and Durham, N. H. It has not been possible to make large tests of all the vegetables, and the present plan is to grow at least the standard varieties, in order to prepare for publication a bulletin on such varieties of vegetables. Later the different vegetables will be taken up until complete tests have been made of all. Extensive tests are being made this year only of beans, peas, cucumbers, beets, and radishes. The work on

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beans will probably be completed this year. The other subjects will require several more seasons to work out completely.

DEMONSTRATION FARMS.—The demonstration farms at San Antonio, Tex., and De Quincy, La., have been transferred to the general southern demonstration work conducted by Dr. S. A. Knapp, while the rice farm at North Galveston will be discontinued at the conclusion of the present crop season. It was found that the inconvenience of reaching the farm from any central point operated severely against the usefulness of the place as a demonstration farm. At San Antonio this Office will retain a field of approximately 10 acres on which plat tests of new introductions will be conducted. At this place it is hoped to test all the seeds and plants that appear adapted to the semiarid conditions prevailing in this part of Texas and to produce limited quantities of stock seed of such lots as appear worthy of introduction.

GENERAL WORK ON SEEDS AND PLANTS.—During the fiscal year 1906 the number of packets of vegetable seed that will be distributed is 32,190,000, and of flower seed 3,625,000. The bulbs distributed will consist of iris roots. The Japanese iris will doubtless thrive in most parts of the United States, and the culture of this charming hardy perennial should be encouraged. Special arrangements have therefore been made for the purchase of 12,000 first-size roots of 24 standard varieties.

Cotton seed.—Work with wilt-resistant and other new varieties of cotton similar to that carried on during the past year will be kept up, with the cooperation of the Office of the Pathologist and Physiologist.

Tobacco seed.—The work done during the past year by Mr. A. D. Shamel on selecting tobacco seed has been so markedly successful that this Office, following up the policy of taking advantage of every opportunity to put before the people the results of such good work, has made arrangements to have all the tobacco seed distributed during 1906 specially selected by Mr. Shamel or by one of his assistants. The regular quotas will not be assigned in the Congressional distribution, because it would not be practicable to secure selected seed enough to fill all the usual quotas, but there will be plenty of seed, so that it will be possible to comply with every serious request for improved seed.

Sugar-beet seed.—The work in connection with sugar beets is being carried on at the same stations as during the past year. During the coming autumn it is hoped to harvest seed from a large number of selected roots now growing and to harvest thousands of roots grown from our own pedigree seed.

The comparative tests of varieties are being continued, and observations will be made on the results secured from the 18,500 pounds of seed distributed this spring.

The Department has also made arrangements with the several factories which bought 34,500 pounds of seed last year from Col. E. H. Morrison, a grower of sugar-beet seed at Fairfield, Wash., whereby it will, in all probability, be able to learn the actual commercial results secured by the use of this seed. These same factories obtained something more than 100,000 pounds of seed from Col.

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Morrison this spring, and an effort will be made to make a similar arrangement with them to advise the Department of the results achieved.

Bulb growing.—Arrangements have been made with certain bulb growers to furnish the Department with specific data concerning the outcome of experiments in bulb production, the Department to supply the stock bulbs and in some cases to pay for the actual labor of conducting the work. Experiments will be made to ascertain the effect of fertilizers on the growth and quality of bulbs, and to learn how soil and climatic conditions affect the commercial production of bulbs.

Cereals.—The testing work with introduced cereals will be confined during the coming year to the stations at Amarillo, Tex., and to a high-altitude station not yet established. The high-altitude work will be done at 5,000 to 8,000 feet elevation, where hardy and quick-maturing barleys and ryes will be tested, and at Amarillo tests of drought-resistant grains will be continued.

Cooperative work with the Drug-Plant Laboratory.—This Office is assisting in a commercial test that will determine whether it will be possible to introduce into this country certain new industries. Those that will receive special attention during the coming year are the production of morphine directly from the poppy capsule and the extraction of camphor. In case the tests shall prove the practicability of the processes devised by the Drug-Plant Laboratory, an active effort will be made to introduce the culture of the plants.

WORK WITH FORAGE CROPS.—The recent transfer to this Office of all of the experimental work connected with the introduction and agricultural extension of forage crops, much of which has heretofore been carried on in connection with the Office of Grass and Forage Plant Investigations, has made it necessary for this Office to greatly extend its work with these crops. Inasmuch as this additional work must be carried on without an adequate provision having been made for the expenses involved therein, it will be possible during the coming fiscal year to do little more than to keep in progress the experimental work already inaugurated. The great importance of this work has been repeatedly referred to, and it is hoped that provision will be made by Congress for conducting it on the scale required by the needs of the country. Many years ago the Division of Seed Distribution introduced some of the most valuable general crops the farmer now has, and with the growth of the country, and especially with the opening up of millions of acres of valuable land in the West, the urgent need for this work is felt more and more every year. There is scarcely a part of the United States where some form of forage crop, grain, or cover crop over and above what the farmers now have is not required. A few experiments with hairy vetch in the Connecticut tobacco fields have already shown how thousands of dollars may be saved in such an old agricultural community by securing the right crop for the special needs of the case. Plans for doing this work as it should be done have therefore been definitely made in the hope that Congress will provide the necessary means.

This work has been placed under the charge of Mr. C. V. Piper, Agrostologist. Assisting him are Mr. J. M. Westgate, who is devot-

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ing his energies mainly to the agricultural extension of alfalfa, and Mr. R. A. Oakley, of the Office of Farm Management, who is paying particular attention to the introduction of new grasses and the further utilization of the standard varieties.

The general plan of this work involves (1) the preliminary and comparative testing of new forage plants, and (2) their introduction and extension.

Testing.—The testing of new forage plants is being done at the permanent testing stations at the Arlington Farm and at Chico, Cal. In addition, similar testing work, but on a less extensive scale, will be carried on at the temporary testing stations at Chillicothe and San Antonio, Tex., and at Pullman, Wash. This preliminary testing will be entirely with the view of determining the value of the plant itself, and especially the particular part of the country to which it may seem best adapted, with a view to its further exploitation and introduction.

In connection with the comparative testing of closely related varieties or species, especially where a considerable number of these have been secured by this Office, an effort will be made to enlist the cooperation of as many of the experiment stations as possible. While most of the stations have not the time to devote to the miscellaneous testing of a great variety of forage crops of more or less doubtful value, they are for the most part very willing to conduct a test confined to a number of varieties of the same species wherever these varieties are so abundant that the testing work is likely to result in some definite information of value to their particular States, and especially where such testing is so extensive that the results can form the basis of publication in a bulletin. By thus providing the seed for extensive comparative tests with various forage crops, this Office hopes to enlist the hearty cooperation of the experiment stations in a greater degree than before.

The work planned on the introduction and extension of forage-crop seed will necessarily bring this Office into close contact with the State experiment stations, even if no specific testing work is undertaken. The relations of this Office with these stations have been uniformly cordial, the broad principle being followed that they are interested in anything that promises to advance agriculture in their States. It is not of course possible to inform every station in regard to all the smaller introductions sent to persons within their States, but whenever specific plans are made for pushing a certain crop, or for the solution of a problem, it will be the policy to communicate with the stations interested and, if possible, secure their cooperation, or at least their cordial support if they do not find themselves able to cooperate actively.

Introduction and extension.—In connection with the distribution of seeds of forage plants upon the request of farmers, personally or through the mediation of Members of Congress, a great deal of time and care is being used in order to secure from such distribution the best results from an experimental point of view. Unless the person who asks for seed agrees beforehand to plant the crop as outlined by this Office and to report fully the results of his experiment, the

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request is not granted. Furthermore, by carefully noting the character of the reports sent in, or the absence of such reports, it has been possible to secure a large list of farmers in various parts of the country who seem especially adapted to the work of testing new forage crops and standard forage crops which are new to their region. In this work it is planned to distribute only such new forage plants as the preliminary trials at the testing stations may indicate to be worthy of field tests, or such other forage plants as are at present grown only in more or less limited areas, but which seem to deserve wider extension in agriculture. With each crop of this sort a definite experimental plan will be provided preliminary to sending the seed. A sufficient quantity will be furnished to make it worth the farmer's care and attention.

It is believed that by demanding increasingly higher standards of reports a large body of reliable experimenters can be secured in every State, and that a high standard of efficiency can be maintained by eliminating all such as do not furnish careful and satisfactory reports. With the thorough organization of such an experimental alliance the miscellaneous distribution of forage-crop seeds can be made to furnish each year a vast amount of data of great agricultural value.

Special attention will be paid during the coming year to the extension of alfalfa in the East and to the testing of the special strains in the possession of the Department; the different strains of Mung bean and the drought-resistant legumes will be further tested and introduced, and the special strains of timothy developed by Doctor Hopkins, as well as selected strains of other grasses, will be propagated. Cooperative work looking to the establishment of hairy vetch or other good legumes as cover crops for tobacco lands will also be pushed.

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REPORT OF THE FORESTER.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., July 1, 1905.

SIR: I have the honor to transmit herewith a report of the work of the Forest Service for the fiscal year ended June 30, 1905, together with an outline of the plans for the work of the Service for the current fiscal year.

Respectfully, GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON, *Secretary.*

INTRODUCTION.

For the Bureau of Forestry, or, as it has now become, the Forest Service, the event of first importance during the past fiscal year was the transfer to its care of the National forest reserves. The act of Congress which accomplished this transfer took effect on February 1, 1905. Upon that day, therefore, a Bureau the duties of which had up to that time been confined to the giving of expert supervision and advice, and which had never had charge of one acre of Government land, was given full administrative control of 63,000,000 acres of public forest, with all the business arising from it.

An administrative system already existed and was transferred with the reserves from the Department of the Interior, together with the appropriation for its support. But the task presented was not merely to coordinate two related organizations, for the transfer was made in order that the National forest reserves might be administered along lines of technical, practical forestry, and so be given their fullest permanent usefulness. It was therefore necessary to merge the former Division of Forestry of the General Land Office in the Bureau of Forestry of the Department of Agriculture.

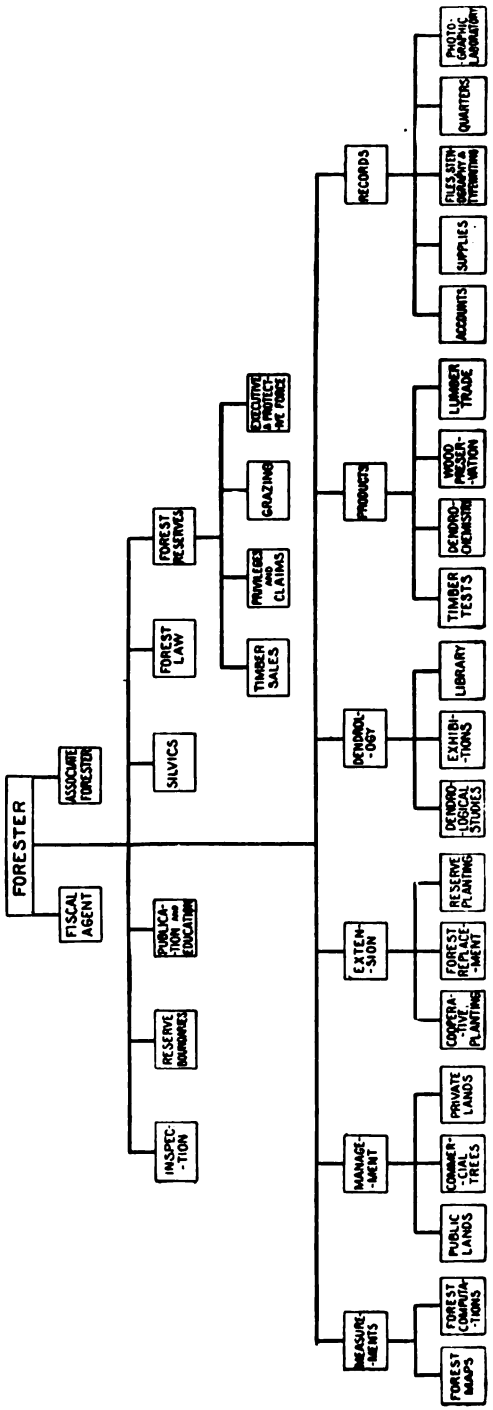
The absorption by the Bureau of Forestry, without disturbance and without the need of any radical change, of the entire administrative organization and lines of work brought out by the transfer is evidence of the character of its work. Its field investigations and accumulation of forest data had been training its men to effective capacity and had built up its organization on broad, practical, and executive lines.

During the past few years the Forest Service has pushed its field investigations and gathered facts in every part of the country. The practical utility of these studies is now made evident. Without the

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knowledge thus secured the Service would be unequal to the task of applying forestry on the reserves along the lines already begun.

ORGANIZATION OF THE FOREST SERVICE.



The Forest Service aims to bring the administration of the reserves near to the people whose wants they serve, and to do business quickly without neglecting any of the necessary safeguards. Under its methods large executive authority is given to local officials, the work is kept at a high standard by frequent inspection on the ground, vexatious delays are avoided, and the practical usefulness of the reserves is vastly increased.

With these changes public approval throughout the West of the reserve policy strengthens from day to day. Assaults upon the reserves will continue from self-seeking interests, as well as from short-sighted persons who are unable to distinguish between an immediate small advantage and a great permanent good.

I wish to bear emphatic testimony in this report to the unremitting steadiness and devotion with which the members of the Forest Service accepted and discharged the new duties laid upon them by the transfer of the forest reserves. The change of method and point of view which followed the transfer brought to many of them new and

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heavy responsibility, and the mass of the new work made demands which could only be met by giving to it for months many hours a day beyond the regular hours. How well they met all the demands upon them is shown by the fact that the new methods were applied and showed results at once upon the transfer, so that the usually unproductive period of adjustment was conspicuous by its absence.

The organization of the Forest Service is shown by the chart on page 200.

INSPECTION.

The Section of Inspection examines and reports on the conduct and progress of the whole field of work conducted by the Forest Service. The inspection work was not formally set apart in a section until after the beginning of the present fiscal year, and therefore calls for no more specific mention in this report. The inspection work of the Service lies at the foundation of its efficiency. It is believed to be in thoroughly good condition.

RESERVE BOUNDARIES.

Examinations for reserve boundaries were conducted during the past year with a combined efficiency and economy which will produce results out of all proportion to the cost, and which would have been altogether impossible of attainment but for the ability and the devotion of the men intrusted with the work. All forest reserves created during the past year had previously been examined by this section. Fourteen men were engaged in this work during portions of the field seasons of 1904 and 1905 in nine of the western States and Territories.

PUBLICATION AND EDUCATION.

During the past year it has become more evident than ever before that to secure the full benefits of the progress in technical forestry made by the Service an active campaign of popular education is called for. The large owners of timber land form a class quick to see the practical bearing of forestry upon their own interests. The small owners, whose aggregate holdings constitute so large a portion of our forest wealth, are less easily reached. Through the press, through the avenues of education opened by school instruction and industrial training, through concrete example, and through the regular publications of the Service, popular opinion must be formed and the knowledge of what constitutes the right use of forest land must be widely inculcated.

The Forest Service has now reached the point at which it can undertake with confidence to advise and guide the forest owners of this country in wise and safe methods of forest management. But not all of the forest owners have yet reached the point at which they are ready to seek and to adopt this advice. During the past year definite plans were made and put in effect to open more widely the stores of information which have been gathered, and this work, than which none more important lies in the immediate future, will be extended and pressed forward just as rapidly as men and means will permit.

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SILVICS.

The work of this section comprises the coordination and classification of all the data gathered in the United States, either by the Forest Service or through other channels, which can be made to contribute to ordered and scientific knowledge of our forests. One of its important functions will be to direct future investigations into the most fruitful lines by making clear where the results already secured are insufficient or inconclusive. The formulation of methods and digestion of the mass of material already accumulated, begun during the past year, is still incomplete, but enough has been done to demonstrate the great value of this work along lines of permanent usefulness.

FOREST LAW.

During the past year the legal work of the Service developed along thoroughly sound lines. Preparation was made for the demands upon it which the transfer would occasion, and when the latter was made it was found possible to deal with the legal work incident to the management of the forest reserves without undue strain. The safety and stability which flow from efficient and conservative legal advice are essential in the kind of work which the Forest Service is called upon to perform.

FOREST RESERVES.

TRANSFER OF ADMINISTRATION.

On February 1, 1905, the administration of the National forest reserves was transferred from the jurisdiction of the Secretary of the Interior to that of the Secretary of Agriculture, except for matters affecting the surveying, prospecting, locating, appropriating, entering, relinquishing, reconveying, certifying, or patenting of lands. By order of the Secretary of Agriculture the Forester assumed immediate charge of the reserves.

The policy of the Forest Service in the administration of the forest reserves has already found expression in the following specific achievements:

(1) Improvement of the technical standards in forest reserve management, by securing the judgment of trained foresters in all questions relating to the reserves.

(2) The reorganization of the Forest Reserve Service, with the specific result that reserve questions are now settled so far as possible on the ground and not in Washington; and the establishment of a corps of trained inspectors, without administrative authority, who constantly and thoroughly inspect all phases of forest reserve work and report upon it to the Forester.

(3) The publication of revised regulations and prompt business methods have brought about a general understanding that the forest reserves are for the use of the people, with a large consequent increase in the business of the reserves and the revenue from them.

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AREA.

The total area of the National forest reserves on June 30, 1904, was 62,582,428 acres. During the past fiscal year new reserves have been created, with a total area of 23,507,934 acres (including additions to existing reserves amounting to 4,356,655 acres), and eliminations were made to the extent of 396,940 acres. The total area on June 30, 1905, was, therefore, 85,693,422 acres. A detailed statement of these changes follows.

Forest reserves, showing new reserves, additions, and eliminations, July 1, 1904, to June 30, 1905.

State.	Reserve.	Area July 1, 1904.	Proclamations July 1, 1904, to June 30, 1905.	Eliminations July 1, 1904, to June 30, 1905.
		Acres.	*Acres.*	*Acres.*
Arizona	Black Mesa	1,658,880		
	Prescott	423,680		
	Grand Canyon	1,851,520	456,000	
	San Francisco Mountains	1,975,310		
	Santa Rita	387,300		
	Santa Catalina	155,520		
	Mount Graham	118,600		
	Chiricahua	169,600		
	Pinal Mountains		45,760	
California	Tahoe	136,335		
	Stanislaus	691,200		63,420
	Sierra	4,057,310	335,530	
	Santa Barbara	1,838,323		
	San Bernardino	737,120		
	San Gabriel	555,520		
	San Jacinto	668,160		
	Trabuco Canyon	109,920		
	Warner Mountains		306,518	
	Modoc		288,218	
	Plumas		579,520	
	Trinity		1,243,042	
	Klamath		1,896,313	
	Lassen Peak		897,115	
Colorado	Battlement Mesa	805,720	52,160	60,160
	Pikes Peak	184,320	678,528	14,880
	White River	970,880		
	San Isabel	77,980	243,247	
	Gunnison		901,270	
	Leadville		1,219,947	
	Medicine Bow		1,155,909	
	San Juan		1,437,406	
	Park Range		757,116	
	Wet Mountains		239,621	
	Cochetopah		1,133,330	
	Montezuma		576,719	
	Uncompahgre		478,111	
	South Platte	654,499		
	Plum Creek	179,200		
Idaho	Bitter Root	3,345,760	515,200	
	Priest River	541,160		
	Pocatello	49,920		
	Yellowstone		177,960	
	Sawtooth		1,947,520	
	Weiser		324,964	
	Henrys Lake		798,720	
	Payette		1,460,960	
	Cassia		326,160	
Montana	Yellowstone	1,229,680		
	Bitter Root	572,480	133,520	14,080
	Gallatin	40,320		
	Lewis and Clark	4,670,720		
	Madison	786,640		16,640
	Little Belt	501,000		
	Highwood Mountains	45,080		
	Elkhorn		186,240	
Nebraska	Niobrara	123,779		
	Dismal River	85,123		
New Mexico	Gila	2,327,040		
	Pecos River	430,880		
	Lincoln	500,000		
Oklahoma	Wichita	57,120		

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Forest reserves, showing new reserves, additions, and eliminations, July 1, 1904, to June 30, 1905—Continued.

State.	Reserves.	Area July 1, 1904.	Proclamations July 1, 1904, to June 30, 1905.	Eliminations July 1, 1904, to June 30, 1905.
		Acres.	*Acres.*	*Acres.*
Oregon	Bull Run	142,080		
	Cascade Range	4,424,440		
	Ashland	18,560		
	Baker City	52,480		
	Wallowa		747,200	
	Wenaha		413,250	
	Chesnimnus		220,320	
	Maury Mountain		54,220	
South Dakota	Black Hills	1,163,320		
	Cave Hills	23,360		
	Slim Buttes	58,160		
Utah	Fish Lake	199,040		
	Uintah	842,000		
	Payson	111,600		
	Logan	182,080		
	Manti	584,640		
	Aquarius	639,000		
	Grantsville	68,960		
	Salt Lake	95,440		
	Sevier		357,000	
Washington	Priest River	103,960		
	Mount Rainier	2,027,520		84,000
	Olympic	1,466,880		
	Washington	3,426,400	560,120	33,680
	Wenaha		318,400	
Wyoming	Yellowstone	6,580,920		
	Black Hills	46,440		
	Big Horn	1,216,960	44,800	110,080
	Medicine Bow	418,759		
Alaska	Afognak	403,640		
	Alexander Archipelago	4,506,240		
Porto Rico	Luquillo	65,950		
	Total	62,582,428	23,507,934	396,940

OFFICERS.

On June 30, 1905, the following number of officers were on duty: Inspectors, 6; superintendents, 2; supervisors, 49; rangers in charge, 5; rangers, 379; guards, 87; laborers, 5; forest assistants (assigned as technical assistants to supervisors), 5.

REORGANIZATION AND POLICY.

The whole Forest Reserve Service was classified under the civil-service law by the President's order of December 17, 1904. The permanent field force now contains the grades of forest inspector, assistant forest inspector, forest supervisor, deputy forest supervisor, forest assistant, forest ranger, deputy forest ranger, assistant forest ranger, and forest guard. All officers will gradually be brought under this new classification as the necessary funds and as men with the required training and experience become available. The object of the reorganization is that the force shall hereafter consist of men of a higher standard of training and experience, appointed and promoted on merit alone, or, in other words, that it shall be as useful to the public which it serves as it is possible to make it.

The old regulations were thoroughly revised. They are now much simpler and more direct and with much unnecessary office work abolished. This revision went into effect on July 1, 1905.

Under the new regulations the responsibility of the men on the

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ground has been largely increased, so that local questions may be decided on local grounds. The work on the reserves is closely and frequently examined and reported on by the inspectors. Rangers are authorized to transact much of the minor business. Trained foresters are or will be assigned as technical assistants to the supervisors on all of the more important reserves. In addition to the regular inspectors, all officers in charge of special lines of work in the Forest Service act as inspectors on the reserves in their lines, and these assistants work under them on the preparation of forest surveys, plans for lumbering and planting operations, plans for protection against fire, and many other matters.

The form of organization places the whole administrative authority in the office of the Forester, and at the same time provides for the conduct, by every other office of the Service, of work on the reserves within its special field.

LEGISLATION.

The act of February 1, 1905 (33 Stat. L., 628), besides providing for the transfer of forest reserves to the Department of Agriculture, stipulates that forest supervisors and rangers shall be selected when practicable from qualified citizens of the States or Territories in which the reserves are situated. It also provides that rights of way within forest reserves for the construction and maintenance of dams, reservoirs, water plants, ditches, flumes, pipes, tunnels, and canals, for municipal or mining purposes, are to be granted by the Secretary of the Interior. The last section provides that all money received from the sale of any products or the use of any land or resources of forest reserves shall be covered into the Treasury for a period of five years and form a special fund for the protection, administration, improvement, and extension of the reserves, to be expended as the Secretary of Agriculture may direct.

The laws providing for the relinquishment, selection, and patenting of lands in lieu of tracts covered by unperfected claims or patents within forest reserves were repealed on March 3, 1905. This removes one of the most troublesome questions connected with the creation and administration of forest reserves.

By the act of February 6, 1905 (33 Stat. L., 700) all persons employed in the forest reserve and National park service are given authority to arrest for the violation of laws, rules, and regulations governing forest reserves and National parks, and persons taken in the act of violating such laws, rules, and regulations may be arrested without process. This act also provides for the export of timber and other forest products from reserves in the United States and Alaska, except from those in Idaho and the Black Hills Reserve in South Dakota.

The President was authorized by the act of January 24, 1905 (33 Stat. L., 614), to set aside suitable areas in the Wichita Forest Reserve as a game refuge, these areas to be under such special regulations as the Secretary of Agriculture may make, provided they do not interfere with the State or Territorial game laws. This was done.

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TIMBER AND WOOD.

During the past fiscal year applications for the purchase of timber were received, and 411 sales were made of a total of 96,060,258 feet, board measure, and 35,202½ cords, for which $85,596.47 were received.

Approximately 40 per cent of the timber and wood sold was dead or damaged by insects, and every effort has been made to dispose of this class of material. The prices obtained were generally low, partly because until February 1, 1905, no timber or wood could be exported from the State or Territory in which the reserves were situated, and for this reason the purchases were for local use and wide competition was lacking. With the law as now amended the sales should soon greatly increase.

No trespass of any magnitude occurred during the year.

GRAZING.

Grazing permits to the number of 7,981 were issued for the season of 1905, for a total of 632,793 head of cattle, 59,331 horses, and 1,709,987 sheep.

No great changes in the number of stock allowed to graze in the different reserves were made. In some of the older reserves, where grazing has been under control for a sufficient length of time to secure an improvement in range conditions, the number of stock allowed was correspondingly increased; in other cases, where the forage crop of the reserves was not being fully utilized, additional allowances were made to accommodate the stock of new settlers and to provide for the natural increase in the herds of those previously occupying the range. In the reserves created at a more recent date, where the ranges were found to have been overstocked, a reduction was made in the number of stock allowed. The result was a marked improvement both in the condition of the range and in that of the stock occupying it.

In reserves recently created all stock which were occupying the range at the time the reserves were established or which were grazed in them during the past season were allowed to graze during the season of 1905 without permits.

CROSSING PERMITS.

Five permits issued under paragraph 22 of the circular of May 22, 1903, allowed 30 head of cattle and horses and 13,200 head of sheep to cross reserve lands to reach areas of private lands within the Sierra, Warner Mountains, and Mount Rainier forest reserves.

Under the regulation allowing stock to be driven across the forest reserves in transit between summer and winter ranges and to reach points of shipment, 341 permits were issued by the forest supervisors for the crossing of 15,136 head of cattle and horses and 749,924 head of sheep. In granting this privilege it is the policy to allow the use of such width of driveway as is necessary and to give sufficient time in crossing to permit the proper handling of stock.

Whenever it is necessary to cross regularly any portion of a reserve which is closed against the grazing of any class of live stock, a regular driveway is established, and the limits and time allowances

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under which it may be used are defined. Such driveways were established in the San Francisco Mountains and Black Mesa forest reserves of Arizona, the Stanislaus and Sierra forest reserves of California, the Big Horn Forest Reserve of Wyoming, and the Salt Lake and Manti Forest reserves of Utah.

HEALTH INSPECTION AND DIPPING REGULATIONS.

The regulation requiring the owners of stock, in districts infected with contagious disease, to submit their stock to inspection by the inspectors of the Bureau of Animal Industry before entering the reserves was willingly complied with in almost every case. The inspection service was efficient, and very little delay was caused by the inspection or treatment of the stock. The forest supervisors were instructed to use every means to facilitate the inspection work, and in some cases additional rangers were employed temporarily to assist in prompt handling.

PREVENTION OF GRAZING TRESPASS.

Several district courts sustained the decision of Judge Wellborn (116 Fed. Rep., 654) that a criminal prosecution did not lie to punish a person who took stock into a forest reserve in violation of the rules. The Attorney-General held that the decision of Judge Wellborn was erroneous, and suggested that prosecutions be proceeded with in other districts, so that a case might be taken to an appellate court for determination. This was done in the case of Dent *v.* United States (76 Pac. Rep., 455), on appeal before the supreme court of Arizona. The supreme court of Arizona, in rendering its final decision, said that the circuit court of appeals for the ninth circuit in the civil case of the United Staes *v.* Dastervignes (122 Fed. Rep., 30) had held that the act of June 4, 1897, did not delegate legislative power to the Secretary and was not unconstitutional; and "that inasmuch as under the act creating the circuit courts of appeal such court exercises appellate jurisdiction over this court in criminal cases such as the one at bar, we feel that a decision of that court, although made in a civil and not a criminal case, expressly holding that the act in question is constitutional * * * is binding upon us in this case;" and ordered judgment in favor of the United States.

The act of Congress approved February 6, 1905, gives the forest officers the right to arrest persons found violating the laws and the rules and regulations relating to forest reserves. This act will result in better protection to the forest reserves.

SPECIAL PRIVILEGES.

The rule of requiring permits for the construction and operation of sawmills within the boundaries of forest reserves was willingly complied with by owners, and worked well. The holders of permits gave valuable assistance in cases of fire.

During the past year 239 applications were received for permission to occupy and use, for various purposes, forest-reserve land under the act of June 4, 1897 (30 Stat. L., 34–36), for which there is no

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other specific provision of law. These and all applications which were not finally disposed of within the preceding year were passed upon, except 18 which required necessary amendment or further report and 9 of such recent date that they have not yet been reached for action. The year's record shows that in the seven months preceding February 1, 1905, action was taken upon 127 applications, and in the five following months upon 161 applications.

In response to requests by the Interior Department for report on applications filed there under the several special acts of Congress relating to rights of way for irrigation, mining, and electrical and other specified purposes, approval of the application has been recommended in 32 cases. In 13 other cases referred to the forest supervisors action is awaiting their report on the effect which approval would have upon forest-reserve interests.

FREE USE OF TIMBER.

The demand for the free use of forest-reserve timber continues to increase. During the fiscal year 3,381 applications were received and 3,363 applications were approved and permits issued by the forest officers and the Department, for a total of 6,263,611 board feet and 40,652 cords, of a total value of $22,925.53.

FOREST MEASUREMENTS.

FOREST COMPUTATION.

The Section of Forest Computation is charged with the computation and final statement of all forest measurements. During the year this section handled the results of 2,301 acres of valuation surveys, 21,234 tree analyses, 9,135 height measurements, and 2,549 taper measurements. Of these data 1,599 acres of valuation surveys, 9,280 tree analyses, 5,141 height measurements, and 2,549 taper measurements were taken in the field during the fiscal year in connection with four working plans, studies of five commercial trees, and four investigations of local problems in forest extension, covering twelve species in ten States. The remainder were data selected from measurements made during previous years in order to make tables of stand, growth, and yield for regional studies of commercial trees. The final tabulating of the public-domain statistics in the appendix to the report of the Commission on the Public Lands was done in the Section of Forest Computation.

FOREST MAPS.

The Section of Forest Maps is intrusted with the making of maps, drawings, and diagrams, the custody of those which are not required for constant use, and the development of the best methods of mapping the forest data collected by the Service. During the past year this section has completed 333 maps and copies, made 85 miscellaneous drawings, mounted 764 maps, and rendered assistance by temporary detail to a total of 563 working days. The work of the year has included the preparation of maps showing conditions upon actual and proposed forest reserves, maps for working plans and planting plans,

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and maps showing the distribution of commercial species, general land and forest conditions, the movements of lumber, and the progress of conservative lumbering. The drawings and diagrams illustrate, among other subjects, the methods and results of testing and preserving timber and methods and appliances employed in forest extension and forest management. The Section made the necessary diagrams and drawings for the exhibit of the Forest Service at the Lewis and Clark Exposition.

WORK FOR THE ENSUING YEAR.

The Section of Forest Computation will continue to put into final form all forest measurements obtained by the Forest Service. Although the number of measurements taken each year is not increasing, this section has large work before it in rendering available for every possible form of use the great volume of forest measurements already on hand. The Section of Forest Maps faces not only the steadily growing demands upon it from investigative and cooperative lines of work, but also the task of building up, so far as this falls within its province, the work in forest mapping essential to the effective management of the forest reserves.

EXPENDITURES.

The total expenditures during the year under the head of forest measurements were $30,158.99, or 7 per cent of the total appropriation of the Forest Service.

FOREST MANAGEMENT.

PUBLIC LANDS.

Immediately upon the transfer of the National forest reserves to the care of the Bureau of Forestry (now the Forest Service), on February 1, 1905, steps were taken to put them under forest management. To permit the use of the standing timber and at the same time to maintain the full productive power of the forest for the future, working plans were needed wherever cutting was to take place. Twenty-six trained foresters were therefore detailed to take charge of this and other technical work on the ground. Five of these foresters were assigned to duty as forest inspectors and twenty-one as technical assistants to forest supervisors, five of whom were on duty by July 1, 1905. The practice of forestry, which makes it possible to harvest the standing timber for the supply of present needs without destroying or diminishing the future usefulness of the forest, has now definitely begun on the National reserves.

Commercial tree studies of western yellow pine and sugar pine in California, western yellow pine in Colorado, Montana, and South Dakota, and lodgepole pine in Wyoming were carried on during the past year. This work is intended to furnish definite information as the basis for careful management of forest reserves on which these trees are the important species and for establishing better rules for lumbering the reserves.

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The work on the Chippewa Indian Reservation, in northern Minnesota, which will eventually become a National forest reserve, has been steadily carried on during the past year, under the act of June 27, 1902, which provided that these lands, with a total area of 231,400 acres, should be placed under forest management. The land on which it was specified that 95 per cent of the timber should be sold at public auction is now being logged. All trees to be left standing on these sections have been or will be marked, and regulations to govern the cutting have been prescribed. The work of removing the timber is going on as rapidly as possible, and is under the constant supervision of the Service.

During the year approximately 10,000 acres were marked for cutting and 6,000 acres were cut. Altogether 50,000 acres have been marked since the work began. Brush burning was completed on 5,645 acres at the end of the year, at an approximate cost of 15 cents per thousand feet of lumber, which was less than one-tenth of what was commonly predicted.

The success of the plan adopted to secure the perpetuation of the forest is entirely assured. Already young seedlings are springing up in abundance, and there can be no question that an ample supply of young growth will be established over the entire forest area. Notwithstanding an extraordinarily unfavorable season, the loss by windfall in the 5 per cent of seed trees left standing has not even endangered reproduction. The loss by windfall was less among the seed trees than in the body of the uncut forest. Even the loss which took place is not a loss of the lumber nor a permanent loss of seed trees, for most of the trees blown down have been logged, and the existence of timber yet to be cut in their near neighborhood has generally made it possible to select others which will be left in their stead.

PRIVATE LANDS.

During the past year the number of applications for advice and assistance in the management of timber lands and wood lots under the offer of cooperation outlined in Circular No. 21 has increased materially. But still more significant and satisfactory than the increase in the number of applications is the wide territory and new localities from which they come. Interest in conservative lumbering and the best utilization of timber lands is undergoing a rapid growth, and nowhere more so than in the West. Both from the Coast States and from the Middle West many applications for assistance have been received during the past year, and the rapid growth of interest has been very marked.

During the year 167 applications were received for advice and assistance in the management of private forest lands. Of these, 45 were for timber tracts, with a total area of 1,439,763 acres, and 122 were for wood lots, with a total area of 7,509 acres. The total area of private lands covered by applications for assistance in management since the publication of Circular No. 21 is 10,947,246 acres, of which 10,917,978 acres are in timber tracts and 29,268 acres in wood lots.

In the case of timber tracts a preliminary examination must precede the preparation of a working plan. Such examinations were made during the year of 22 timber tracts in the States of New York,

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New Hampshire, Pennsylvania, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Arkansas, Missouri, Michigan, Wisconsin, Washington, and California, covering a total area of 500,043 acres. In every case a report was made to the owners giving advice for the management of the tract. For 9 of these tracts the preparation of detailed working plans was recommended and the recommendation approved by the owners. The total estimated cost of these plans to the owners is $10,220, or an average cost of 2 cents per acre.

WORKING PLANS FOR WOOD LOTS.

Working plans based on a thorough study on the ground were made for 81 wood lots, with a total area of 5,340 acres, in the States of New York, New Hampshire, Connecticut, New Jersey, Pennsylvania, Ohio, Maryland, Virginia, North Carolina, Missouri, Alabama, Louisiana, Michigan, and California. The object of this wood-lot work is to give advice and suggestion to farmers and other small owners of timber land, whose holdings in the aggregate form a large part of the productive forest of the country, and for whom forestry can often make a far greater increase of profit in proportion to the capital invested than for large owners. Advice is given the owner personally in the field, and wherever possible thinnings or other operations are actually started under the supervision of the agent making the examination. A written report is then sent to the owner, embodying the recommendations made and giving the reasons for them. Particular attention was paid during the year to wood lots in Ohio, Michigan, and the Lake States, where the question of wood and timber for the farm is often of the greatest importance.

Much valuable information concerning the growth, volume, and yield of different timber trees was gathered in the course of this work, and is now available for use elsewhere. This is the great economy effected by conducting such studies for the public benefit at the public charge. The knowledge which it would not pay the single small owner to gather for himself becomes immensely valuable when, once gathered, it can be broadly applied.

In connection with the wood-lot examinations a number of illustrated lectures were given to various organizations, followed by discussions which proved of great educational value. Much information was also collected as to market conditions, local demands for timber, and the cost of the various logging operations. This information is of special usefulness to farmers, who are often unfamiliar with the timber market.

WORKING PLANS FOR TIMBER TRACTS.

The field work necessary for detailed working plans was carried on during the year upon 8 tracts, with a total area of 1,982,000 acres. The total amount estimated as the cost of these working plans to the owners was $8,575. The 8 tracts included a hard-wood tract in West Virginia, to be managed for a continuous supply of mining timbers; a Kentucky tract, which must be so managed as to yield a continuous revenue and at the same time build up the condition of a badly depleted forest; a tract in northwestern Texas, valuable for the production of fuel and fencing in a region almost destitute of timber;

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a tract in New Hampshire on which a present hemlock and hard-wood forest can be converted into one of white pine, with a promise of largely increased profits; a tract in western Washington, the study of which disclosed important facts concerning the usefulness of forestry in connection with the production of Pacific coast fir; a tract in eastern Washington on which it was found that a fair second cut can be obtained within a reasonable period by the application of proper methods of handling; an Idaho forest likely to become an important source of supply of mining timbers as well as a protective agency for the water necessary to the development of the surrounding country, and a northern California tract on which it appeared that management would pay well if fire could be kept out, and for which a plan to secure fire protection was made.

STUDIES OF COMMERCIAL TREES.

During the past year much attention was given to studies of commercial trees. The purpose of these studies is to secure full and accurate knowledge of the requirements and habits of each individual species of our more important forest trees. Not only are such studies valuable contributions to our knowledge of North American forests, but they are of material service for forest management and the successful preparation of working plans. It is the present aim to supplement the determination of volume and yield by thorough investigation of the value and uses of the timber, demand, general market conditions, the best methods of lumbering and handling, and the most profitable means of utilizing the trees under various circumstances. Such information as this has already been of great value in showing where waste, both in logging and in utilization of the timber, can be avoided.

SOUTHERN APPALACHIANS.

The Southern Appalachian region is of foremost importance to the hard-wood interests of the United States, because of the great extent and value of its hard-wood forests. The Forest Service has collected during a number of years volume and growth measurements for several species in various parts of this territory, chiefly in connection with the making of working plans. During the past year the work of correlating and rounding out the data previously collected was undertaken.

Yellow poplar, white, red, black, and chestnut oaks, chestnut, white pine, and hemlock were studied in West Virginia, Kentucky, and Tennessee, and the mountainous portions of Maryland, Virginia, North Carolina, South Carolina, Georgia, and Alabama. In addition to the field work, a careful market study was also made of all the species under consideration. The demand for these timbers has increased enormously within the last ten years, the available supplies are rapidly diminishing, and stumpage prices are rising very fast. A comprehensive market study is thus of special timeliness.

In preparing this market study, a general canvass was made of the lumbering centers of the Southern Appalachian region. Information was obtained at each point concerning the remaining stand of timber of each species and its quality, the annual cut and its uses,

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new uses and substitutions, the market supplied, and land and stumpage values. Special attention was paid also to the cost and methods of logging and milling, and to current grades and specifications. Sixteen localities, believed to be typical of the forests of the region, were then selected for detailed studies of silvics and lumbering. In addition, four other typical localities were studied by special parties, two in connection with the second-growth problem and two for the cooperage industry. Careful studies were made of the characteristics of the forest, the individual habits and requirements of each species, the effects of fire and grazing, and the methods and effects of lumbering upon the forests, more especially as regards waste in logging and means of preventing this waste. Upon these various studies are based plans for conservative forest management under varying forest conditions.

The report upon this great hard-wood region, which is now nearing completion, will contain a large amount of information concerning commercial and forest conditions and their relation to the lumber, cross-tie, tight and slack cooperage, mining, timber, tan-bark, and chestnut extract wood industries. Based upon this information, definite suggestions will be given as to methods of utilizing the forest products to better advantage and as to practical means of managing forest properties more conservatively.

COTTONWOOD AND ASH.

During the winter the Forest Service carried on a study of cottonwood and ash in the South. This study was supplementary in part to the study made the preceding year of the red gum, and combined with this, furnishes a complete basis for the forest management of hard-wood bottom lands in this region.

Nowhere is forest management more promising than on these hard-wood bottom lands. The growth of all species, particularly the cottonwood and ash, is here extremely rapid, and nearly all the species are now easily merchantable. The measurements taken on the cottonwood show it to be one of the fastest growing trees native to the United States. Ash, while not so fast in growth as either cottonwood or red gum, will make saw logs in about fifty years, and can be used when much smaller for many purposes. The chief obstacle to be overcome is, in many localities, the dense growth of canebrake, which often renders reproduction difficult, if not altogether impossible. Burning will undoubtedly prove the most efficient means of destroying this growth.

LODGEPOLE PINE.

A study of the lodgepole pine in Montana, Utah, and Wyoming was carried on during the summer and fall. The object was to collect exact information with regard to silvics, commercial status, and methods of lumbering, which information, combined with the large number of growth and volume measurements obtained by the Service during the past four years, will furnish a basis for the correct forest management of this species.

At present lodgepole pine, despite its wide geographical distribution and the fact that it forms four-fifths of the forests of the Rocky Mountain region, is not commercially a well-known tree. It is,

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however, rapidly gaining in general utility. For example, experiments have already shown that railroad ties of this tree, when impregnated with a proper preservative, satisfy the necessary requirements as to length of service, and its utilization for this purpose, as well as for mining timbers, seems to be assured.

The chief obstacles to forest management on lodgepole lands is the repeated forest fires that annually burn over large areas, and one of the main objects of this study was to discover how to control and prevent these fires. Particular attention was also given to the matter of waste in logging and to the disposal of slash and tops. This slash left after logging forms one of the greatest obstacles to fire prevention, for it becomes very dry and inflammable in summer and makes a very hot fire. With an efficient system of fire protection forest management promises to be highly successful for lodgepole pine timber lands.

WESTERN YELLOW PINE.

A study of one of the most important commercial timber trees of the West, the western yellow pine, completed during the year, was made to determine the best methods of management of this species, based on its reproduction, rate of growth, and silvicultural characteristics. Measurements of sample plots and of the rate of growth and actual volume of felled trees were made in South Dakota, Colorado, Montana, and California. The tables obtained will be of great assistance to timber-land owners in estimating the amount of standing timber on their lands and the rate at which it will grow.

In addition, the commercial distribution of the species was mapped, and a careful study was made of market conditions, methods of lumbering, uses of the wood, and the characteristics of the tree, including its requirements as to soil, moisture, elevation, etc.

SUGAR PINE.

In connection with the study of the western yellow pine in California, the study of sugar pine in that State, begun in 1902, was completed. The sugar pine is one of the important timber trees of the coast, but a difficult species to manage under prevailing conditions. Fire protection on cut-over lands is the most important consideration. The report on this species will contain volume and rate of growth tables and carefully prepared silvicultural notes, and will furnish much information of practical value.

SCRUB PINE.

During the spring months the Forest Service carried on a study of the scrub pine in Virginia and Maryland, in order to furnish information to farmers and timber-land owners in these States, where there are large areas of abandoned farm land covered with dense stands of this species. Particular attention was given to market conditions and present and possible uses of the species, especially for pulp wood and lumber.

SPECIES USED FOR RAILROAD TIES.

The tie problem in this country is becoming more important every year. The study of loblolly pine in eastern Texas, with special refer-

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ence to tie production, was completed during the year, and a similar study was begun in the hard-wood region of the Southern Appalachians, westward to the Mississippi River. White, black, and chestnut oaks were the species principally studied. The fact that the tie industry in that region is confined almost exclusively to second-growth forest made desirable a general study of the second-growth land, its extent, character, and annual production, and of the proper methods of managing it for a sustained yield of the timber demanded in the region, both for ties and for the mining and other industries dependent upon wood.

DETERMINATION OF TIMBER VALUES.

A piece of work which the Forest Service has carried on during the past year and which makes a strong appeal to lumbermen is that of determining the precise money value of trees of the different diameters. This work, begun less than two years ago, has been steadily developed. It furnishes in many cases the strongest possible argument for conservative forest management.

The timber owner who undertakes to practice forestry must make up his mind to leave a certain percentage of his trees uncut as a basis for future timber crops. Hence the first question he wants answered is, What are these trees worth now, and what will they be worth when they have reached a larger size? In brief, will it pay to let them alone for a while?

This study supplies the exact information required. The trees are marked in the woods as they are felled, and then traced through the sawmill to learn what they saw out. From the figures thus obtained tables are constructed which show the number of board feet of each grade of lumber yielded by trees of different diameters. By applying a lumber price list the exact money value of the trees may then be determined.

This study at sawmills also shows exactly how the actual amount of lumber sawed out of a log or tree compares with the amount credited to it by the log scale. This is a matter of considerable importance, especially to lumbermen who contract for their logging. The tables showing money values can be applied with peculiar effectiveness to those tracts on which detailed estimates have been made of the standing timber. Knowing the number of trees of each diameter and species on his lands, and the profits per thousand feet of logging each diameter, the lumberman is in a position to put a far more accurate valuation on his property than if he had resorted to the customary method of having it cruised and had then applied a stumpage price. Success in the lumber business depends largely on the ability to figure closely on all operations. The mill studies of the Service thus furnish the precise information necessary for very important calculations.

WORK FOR THE ENSUING YEAR.

PUBLIC LANDS.

During the coming year the preparation of working plans for those parts of the National forest reserves where there is an urgent demand for timber and where large timber sales have been made will

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be carried on as rapidly as the resources of the Service will permit. Studies of the more important species occurring on the reserves will be pressed forward. Those species which are of commonest occurrence or of most importance to correct forest management will be studied first.

WORKING PLANS.

Working plans will continue to be made for private tracts. Several working plans, which will be completed during the coming year, have already been begun. They are as follows:

Two working plans for small tracts in New York, on which the actual carrying out of the recommendations to be made will be started by the Service. The present stand and distribution of the timber will be shown by forest maps, and the future stand will be estimated from growth figures collected on the tracts. The execution of these plans will afford practical examples of forest management for residents in the vicinity.

A working plan for a tract of 100,000 acres in northern New York, which the owners wish to manage so as to obtain the largest returns from continued cutting and on which present returns are not the first requirement.

Three working plans for small tracts in California. The protection of the forest from fires is here most important, and the results of this work will be of the greatest value to timber-land owners in that region.

The working plan for the tract of 1,300,000 acres in western Washington begun last year. The chief object of this work will be to outline an efficient fire-protection system and to perfect plans for future lumbering, so as to obtain continued cuts of timber.

A working plan for a tract of about 7,000 acres on an island in Lake Michigan. The work will include the making of a forest type map showing the distribution and character of the timber, an estimate of the present stand, plans for the removal of mature timber and for improvement cuttings and thinnings in second growth, and a planting plan for open and burnt areas. The situation of this tract, on a small island, renders the question of fire protection particularly easy.

In addition to these working plans, which are already under way, a working plan will be made for a tract of land in Kentucky and Virginia, which the owners wish to hold mainly for the permanent production of mining timbers. The forest is as yet practically uncut, and the opportunities for successful forest management are very great.

Working plans will be made for at least two large tracts of longleaf pine land in Arkansas, including studies of fire protection and less wasteful methods of lumbering. A working plan will also be made for a tract of longleaf and loblolly pine land in South Carolina.

A detailed plan for protection of forest lands from fire will be made for one of the large railroad companies in California and Oregon. The essential features of this work will be the adoption of a system of fire patrol and the prevention of fire from starting by improved methods of logging and by burning brush and slash left after logging.

In addition to these working plans for timber tracts attention will be given, as in the past, to working plans for wood lots. The oppor-

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tunity which this work affords of introducing better forest management throughout the country is very great, and the examples of thinnings and other work furnished by these wood lots are of great advantage to neighboring timber-land owners.

STUDIES OF COMMERCIAL TREES.

The Forest Service will continue its commercial-tree studies during the coming year. It will be the object to complete as rapidly as possible the studies of those trees which are of the greatest importance commercially, or in the management of forest lands. Work will also be carried on along special lines of investigation, such as the production of railroad ties and studies of second growth in various parts of the United States. The study of lodgepole pine will be continued during the coming year so as to cover its entire range, special attention being given to market conditions, waste in logging, and the best methods of reproduction of lodgepole pine forests. Other commercial trees to be taken up will be the Engelmann spruce in the West, the red cedar in the South, the red pine in Minnesota (for which sufficient field measurements have already been collected), and the white fir as a source of supply for pulp wood in Oregon and Washington.

A cooperative study of future supply of railroad ties will be carried on in Wisconsin and Minnesota. The investigation will determine the possibility and cost of producing ties in these States on lands tributary to the cooperating road.

The mill studies to determine the actual money value of trees of different diameters and the amounts of each grade of lumber cut from the trees will be continued, and the longleaf and loblolly pines in South Carolina will be studied.

Studies of second-growth white pine will be carried on in New England, and a study of second-growth hard woods will also be made. This work is of particular importance from its bearing upon the management of small timber tracts and wood lots.

COOPERATIVE STATE FOREST STUDIES.

MAINE.

A descriptive study of forest fires was carried on and completed during the past year in cooperation with the State of Maine forest commission. Particular attention was given to the causes of fires and to the effect of fires on the forest, reproduction, and second growth. The present methods of fighting fires and the efficiency of these methods were also studied, and figures were collected to show the actual damage done to the forest. On this work are based recommendations for the prevention and control of fires.

WORK OF THE ENSUING YEAR.

In cooperation with the New Hampshire forest commission, a study will be made of forest conditions in the southern part of that State. This work will be a continuation of the work already done in the northern part of New Hampshire. The lines to be followed are:

(1) A study of the composition and quality of the forest and the completion of the forest map of New Hampshire.

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(2) A determination of the actual yield of merchantable timber possible from second-growth forest under forest management.

(3) A study of the present methods and extent of lumbering in the southern half of the State, and of practicable modifications to improve the condition of cut-over lands.

(4) A study of the values and uses of the various woods, and of the returns which can be expected from second-growth forest and wood lots.

(5) The completion of the stream-flow measurements in cooperation with the United States Geological Survey.

EXPENDITURES.

The total expenditures under forest management during the past year amounted to $57,082.25, or 13¼ per cent of the total appropriation for the Forest Service.

FOREST EXTENSION.

The forest planting operations conducted during the past year by the Forest Service fall into two main classes—cooperative planting, which concerns itself with planting on private land under the cooperative arrangement outlined in Circular No. 22, and reserve planting operations and forest replacement studies, both of which are concerned directly with the work of reforestation on the forest reserves.

COOPERATIVE PLANTING.

The same general policy of cooperative forest planting which has been followed since July, 1899, was continued during the past year. Upon application, examination is made, whenever practicable, of lands upon which the owners contemplate forest planting. If after this preliminary examination a planting plan seems advisable, detailed instructions as to what and how to plant are given. In case extensive planting is to be undertaken its supervision by an agent of the Service is usually recommended. The assistance offered does not include the preparation of plans for landscape gardening or decorative planting of any kind, and such work is entirely outside the province of the Forest Service.

RESULTS OF COOPERATIVE PLANTING.

During the past year 50 landowners applied for assistance under the terms outlined above, and at the beginning of the year 52 applications were awaiting attention. Of these applications 49 were acted upon during the year, and 46 planting plans were made, covering an aggregate area of 36,570 acres, in 21 States. There are now 46 applications on file to receive attention during the coming year. The following is a summary, under fiscal years, of operations from the inception of the cooperative forest-planting policy, in 1899, to June 30, 1905:

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Fiscal year.	Applications received.	Examinations made.	Plans made.	Area covered by plans.
	Number.	*Number.*	*Number.*	*Acres.*
1900	117	62	59	482.55
1901	75	118	114	2,574.45
1902	70	55	51	3,467.27
1903	63	69	68	4,283.20
1904	70	53	42	2,861.83
1905	50	49	46	36,569.70
Total	445	406	380	50,238.50

INCREASE OF COOPERATIVE FOREST PLANTING.

The most notable phase of the cooperative planting work during the year has been the increasing requests for assistance made by cities, water companies, railroads, and other large owners. A forest nursery was established and a planting plan is being made for some 25,000 acres of denuded land along the Chateaugay division of the Delaware and Hudson Railroad in the Adirondacks, while for the Baltimore and Ohio Railroad an examination was made of several parcels of land in West Virginia, Ohio, and Pennsylvania. A planting plan was made and planting was begun on a 3,000-acre forest park for the city of Los Angeles, Cal., and application was received for a similar plan for a large forest park in the city of Helena, Mont. Watershed planting is receiving increasing attention, and the practical bearing of reforestation upon irrigation and various industries is becoming more thoroughly recognized. The Fort Bayard Military Reservation was examined for the War Department. A planting plan was made for 4,000 acres of the reservation, and a nursery was established. The development of these large projects indicates the increasing scope of cooperative forest planting, and is a natural result of earlier educational work and of increasing needs.

INVESTIGATIONS OF PLANTED AND NATURAL TIMBER.

The field studies to accumulate all available data on forest planting have been continued in the Middle West, in order to determine for definite regions the best species for commercial and protective planting, the best cultural methods, and what may be expected from the species planted. Such studies were completed last year in North and South Dakota, western Minnesota, Illinois, eastern Nebraska, and western Texas. A similar study is being made in Iowa.

POPULAR INFORMATION.

Leaflets on the planting range, silvical qualities, proper methods of propagation and care, and economic uses of such trees as can be recommended for commercial and protective forest planting, and on common subjects of inquiry, such as spacing, transplanting, heeling in, packing and shipping young trees, and the cultivation of forest plantations, have been prepared and printed. To supplement the planting leaflets a mimeographed sheet for each important species has been prepared, giving the range of quotations for seed, seedlings, and transplants, and list of dealers from whom planting material may be obtained.

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To further the work of cooperative forest planting, public meetings were held and lectures were given in North Carolina, Iowa, Illinois, and Nebraska.

RESERVE PLANTING.

SAN GABRIEL FOREST RESERVE.

During the past year the two established nurseries in the San Gabriel Forest Reserve were consolidated by the removal of the lath house of the Pasadena nursery to Henningers Flat. By this change the productive capacity of the Henningers Flat nursery was increased about one-third. There are now about 11,520 square feet of ground under lath. This area has been replanted to seed beds since the removal of the 1-year-old stock to open ground. The seeds sown should produce about 300,000 plants. The species mainly used were the Jeffrey pine, big cone spruce, knob cone pine, and Coulter pine, in the order named. For field planting in the San Gabriel Reserve 2-year-old trees once transplanted are most desirable. During March of this year 210,700 1-year-old seedlings, chiefly of these species, were transplanted from the seed beds in the lath house to nursery beds and the loss will not exceed 0.047 per cent.

To check the rapid height growth of certain species, as the Coulter and Monterey pines and big cone spruce, and thereby to secure stocky plants which rabbits will not molest, "topping" was tried. Several thousand trees were cut back three-fourths of their length before transplanting, and others when transplanted, with very satisfactory results. A root-pruning knife was devised, with which the roots can be cut at any depth from 3 to 10 inches. It has been used only experimentally, but thus far with gratifying success.

During April and May of this year 37,000 trees, chiefly 2-year-old transplants, were set out, in greater part for experimental purposes. For the protection of the Henningers Flat nursery and the new forest plantations, a system of fire lines was laid out and constructed after the completion of the planting.

To promote the reforestation of the watersheds and to extend the range of experimental planting, 8,560 trees were given to the city of Los Angeles for planting in Griffith Park and 3,106 to individuals in lots of from 150 to 1,500. All the trees were planted under instructions from the Service, and, except in two cases, were set on watersheds within forest reserves.

SANTA BARBARA FOREST RESERVE.

In view of the extremely high value of water in the vicinity of Santa Barbara and of the denuded condition of the important drainage basins, reforestation work was begun in the Santa Barbara Forest Reserve in March, 1905. A forest nursery was established within the reserve, at an elevation of 2,000 feet, on the San Marcos road, 13 miles from the city of Santa Barbara. The necessary land and water privileges were secured by lease. A lath house covering 5,760 square feet of ground space was erected, in which seed beds were prepared and seed sown.

A detailed planting plan for the watersheds in urgent need of reforestation will be completed during the summer. The Mono Basin and the watersheds of the Santa Ynez River above the Gibraltar reservoir site will receive first attention.

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PIKES PEAK FOREST RESERVE.

During the field season of 1904 three nurseries were established in the southern portion of the Pikes Peak Forest Reserve to furnish seedlings for planting on the fire-denuded slopes of that region. In the fall about one-fifth of an acre of seed beds was planted with seed of Engelmann spruce, blue spruce, Douglas spruce, limber pine, western yellow pine, and bristle-cone pine. Forty thousand western yellow pine and 10,000 Douglas spruce seedlings from the Government nursery at Halsey, Nebr., were planted on the mountain slopes near Clyde.

GILA RIVER FOREST RESERVE—FORT BAYARD MILITARY RESERVATION.

An examination of the adaptability of the Fort Bayard Military Reservation for forest planting, made in cooperation with the War Department in April, 1905, was followed by the selection and leasing of a nursery site at Stevens ranch, north of the military post, at the only point where the necessary water rights could be obtained. An acre of ground was prepared as a nursery, and seed beds with a productive capacity of 3,000,000 seedlings were sown. About 300 pounds of seed of western yellow pine were used. They were sown with a seed drill, at a cost of less than 5 cents per pound; hand sowing would cost about 50 cents.

BLACK HILLS FOREST RESERVE.

Reforestation work was begun in early June. On 32 acres western yellow pine seed was sown broadcast. An area of 8 acres was planted to seeds of the same species with a hand corn planter, improved for the purpose, and 30,000 western yellow pine and 10,000 red fir seedlings raised in the Dismal River Forest Reserve nursery were set up, 2,000 to the acre. The operations were in the vicinity of Custer Peak, near Roubaix, on the site of an old burn.

DISMAL RIVER FOREST RESERVE.

Created primarily as a tree-planting reserve, the Dismal River Forest Reserve was the first on which planting was begun, and is still the scene of the most extensive reserve planting directed by the Forest Service.

NURSERY WORK.—In September, 1904, a careful estimate based on sample-plot counts showed that the nursery stock at that time consisted of 990,000 western yellow pine, 1,119,000 jack pine, 7,800 red fir, and 50,000 white fir seedlings. Of these the western yellow pine, red fir, and white fir came through the winter with probably less than 5 per cent loss. The jack pine suffered a loss of about 75 per cent through winter killing and the attack of a fungus.

The cost of raising these seedlings to one year old, including cost of the seed and one-tenth of the cost of constructing the shade frames, amounted to not more than 85 cents per thousand. These seedlings, as well as the other trees, are prospering.

The area devoted to seed beds is now 2½ acres. One-half of this area was sown to western yellow pine and jack pine this spring. The remaining 1¼ acres contain one-year-old seedlings of western yellow

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and jack pine and red and white fir, which will be left in the beds another year before transplanting.

FIELD PLANTING.—Field planting was begun on April 11 and finished in early May. A total of 396,100 trees of jack pine and western yellow pine was planted in the sand hills at an average of $2.15 per thousand trees. The method of planting was practically the same as that followed the previous year, described in the 1904 report. All of the jack pine was planted in the grass sod without previous preparation. Of the 274,700 western yellow pine 80,400 were planted in sod and the remaining 194,300 in furrows. The trees planted this year are in a thrifty condition and appear to be making a good start.

SEEDS AND TREES FURNISHED FOR PLANTING OUTSIDE OF THE DISMAL RIVER FOREST RESERVE.—In May 300 pounds of western yellow pine seed, 30,000 seedlings of the same species, and 10,000 red fir seedlings were furnished for reforestation in the Black Hills Forest Reserve. Fifty thousand western yellow pine seedlings and 10,000 red fir seedlings were shipped to the Pikes Peak Forest Reserve, and 400 pounds of western yellow pine seed were sent to the newly established nursery at Fort Bayard, N. Mex.

EXPERIMENTAL PLANTING.—Although the work up to the present has been very successful, sand-hill planting is yet in an experimental stage. To secure further data a quarter section of typical sand-hill country was set aside for experimental purposes. Planting was done on this area with different species, both in and out of furrows, and each tree and block was carefully staked and recorded, so that accurate counts can be made at any time. In addition certain trees and blocks in the larger field plantations were staked, that the results may be more accurately determined.

COLLECTING AND TESTING OF FOREST TREE SEEDS.

It is the policy of the Service to collect the seeds used in reserve planting, though as a large quantity gathered in 1903 was on hand at the beginning of the last fiscal year no collecting was needed in 1904. In this connection germination tests and data as to the vitality and methods of preservation of the seeds are essential. Cooperative work was carried on with the Seed Laboratory of the Department through a series of experiments, field germination tests were made at Halsey, Nebr., and Henningers Flat, Cal., and a report on preliminary results was prepared. On the whole, the seed collected by the Service was of better quality than that purchased of seed houses.

FOREST REPLACEMENT.

The study of forest replacement on areas where tree growth is wanting or deficient was continued in the Wichita, Prescott, Pikes Peak, Santa Barbara, San Gabriel, San Bernardino, San Jacinto, and Sierra reserves. Studies similar in character, although less exhaustive, were carried on in connection with reserve and cooperative planting and with the studies of natural forest encroachment.

Forest-replacement studies serve as a preliminary reforestation plan. Through such studies the areas on which planting is advisable

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are definitely determined, species selected, nursery sites located, disposal of brush and dead timber considered, preliminary fire plans made, and an estimate is given of the cost of the several operations.

During the year the field investigations of forest replacement in the Santa Barbara Forest Reserve, inaugurated and carried nearly to completion in the fiscal year 1904, were finished, and the preliminary office report was compiled in the form of locality and reproduction studies.

The forest-replacement studies in the Sierra Forest Reserve were completed in December, 1904. A full office report describes the types of the Sierra forest, the extent to which natural reproduction may be depended upon to reclaim chaparral and reforest denuded areas, the areas on which planting is advisable, and the species suitable for planting.

An investigation of the advisability of forest planting for timber supply and water conservation in the Salt Lake Forest Reserve was made during the summer field season. One valuable result was the beginning of hearty cooperation with the municipality of Salt Lake in the interest of the city's water supply. The eastern part of the Lewis and Clark Forest Reserve was examined to determine whether the condition of the watersheds, the state of settlement, and the value of the water and timber supplied by this region are sufficient to warrant the preparation of a reforestation plan. An examination was also begun to determine the advisability of forest planting on denuded slopes in the Gunnison Forest Reserve, in Colorado, in connection with the Uncompahgre Valley irrigation project of the Reclamation Service.

STATE COOPERATIVE WORK.

The forest investigations in cooperation with the State of California which began in July, 1903, were finished. Studies were conducted by the Office of Forest Extension on the chaparral, its growth, extension, functions, and the means of controlling it, and on forest fires. The latter resulted in completed reports on fire conditions in the San Bernardino, San Gabriel, Santa Barbara, San Jacinto, and Trabuco Canyon forest reserves, and in Monterey County, on the western slope of the southern Sierras, and in the Lake Tahoe region. In addition, a systematic plan of fire protection was made and put into operation on a lumber tract in Butte County, and reports on slash burning and general fire protection were prepared. Most important of all, a State forest code, based on a thorough field study, was submitted to the legislature, and was passed in somewhat amended form. It provides for the protection and management of forests within the State, and creates a State board of forestry and a technical administrative force consisting of a State forester and two assistants. A general report on fire conditions in California is in preparation.

EXPENDITURES.

The expenditures of the Office of Forest Extension during the past year amounted to $53,970.96, or 12½ per cent of the appropriation of the Forest Service. Contributions amounting to $3,792 were received

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and expended on cooperative work. Among the contributors were the State of California, the Los Angeles Chamber of Commerce, the Pasadena Board of Trade, and the Solar Observatory, Mount Wilson, Cal.

WORK FOR THE ENSUING YEAR.

COOPERATIVE PLANTING.

The preparation of planting plans under the provisions of Circular No. 22 will be continued, and effort will be made to extend the work by bringing the cooperative offer to the attention of a greater number of landowners. The study of planted groves in Iowa will be completed. It is expected to lead to more active cooperation between the Service and railroads, pulp companies, and others interested in forest planting. Attention will be given to planting over the coal beds in the Ohio Basin which are unproductive or giving only small returns from agricultural crops. The black locust will be studied with care, because it is the species in greatest favor for planting in this region.

RESERVE PLANTING.

The reserve planting projects on the San Gabriel, Santa Barbara, Pikes Peak, Gila River, Black Hills, and Dismal River forest reserves will be continued and extended. In connection with this a large quantity of tree seeds will be collected this fall.

In the Garden City Forest Reserve, created primarily as a tree-planting reserve in June, 1905, active operations will begin this fall by locating the site and preparing the ground for a nursery. The planting of seed beds will follow next spring.

If favorable reports are submitted for the reserves on which preliminary reforestation plans are now being made, the establishment of additional forest nurseries will be advisable in the spring of 1906. These reserves are the Salt Lake, Prescott, Lewis and Clark, Gunnison, Modoc, Warner Mountains, Cassia, and possibly the Malad.

DENDROLOGY.

FOREST DISTRIBUTION.

FOREST MAP OF THE UNITED STATES.

The collection of data for mapping the forest types and the distribution of tree species in the United States was continued during the year. A map showing the great types, prepared for the Louisiana Purchase Exposition, was printed, and marks a considerable advance in accurate knowledge. But the satisfactory completion of this most important undertaking must be the work of years. Until it is completed, knowledge of the extent and economic possibilities of our forest resources must remain fragmentary.

STUDIES OF SPECIAL REGIONS, GROUPS, AND SPECIES.

A study of the distribution, composition, and commercial value of bottom-land forests in the "Big Thicket" region of southern Texas was conducted during the year.

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Progress was made in a study of important indigenous and exotic acacias growing in the United States. Through the unfortunate loss of field notes by the burning of the Santa Monica Experiment Station buildings, however, much of the work done will have to be undertaken anew.

A study of eucalypts for growing where there is little frost is in progress. New and definite knowledge has been obtained of the exact limits within which various species can be successfully cultivated in parts of the West and Southwest.

PACIFIC COAST TAN-BARK TREES.

Material has been collected for a complete report on the present and probable future supply of western tan-bark oak, of the extent to which it is likely to meet the demand of the Pacific tanning industry, of new species capable of supplying tan bark, and of the various barks which have been used as adulterants.

BASKET WILLOWS.

The basket-willow holts established last year on the Arlington Experimental Farm yielded their first crop of rods from 10,000 stools in the spring of 1905. Some of this stock was peeled, some dried with the bark on, and the remainder used for cuttings to extend the plantation. The peeled and unpeeled rods will be made into various forms of produce and farm baskets and placed in actual service to determine whether they are enough more durable than the cheaper but comparatively much shorter-lived splint-wood baskets to make them more economical in the end.

From the total crop of rods valuable comparative data were obtained as to the production of different willows on different soils, and the effect of different treatments on the quality and quantity of the rods, and, in cooperation with the Bureau of Entomology, on means of preventing insect ravages.

The holts now contain 20,000 stools, distributed in 30 plats, and the plantation is well equipped. The Bureau of Plant Industry, which assigned the land for these experiments, has rendered most cordial and helpful cooperation in preparing the ground and in many other ways.

The appearance of Bulletin 46 (The Basket Willow) awakened an interest in willow growing, and many requests are received for cuttings of approved strains of basket willows. It is planned to meet this growing demand by distributing from 50,000 to 100,000 cuttings during the spring of 1906.

TURPENTINING METHODS.

The series of experiments to secure an improved system of turpentining begun in 1902 was completed in December, 1904, and the final results were published in Circular 34. These experiments made known a means by which the length of life of the turpentined pine forests is greatly lengthened and at the same time both a larger and a better product is obtained. The study already made has received the hearty commendation of the body of operators who produce the

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major part of our naval stores and has led to the offer of willing cooperation in further studies.

PURPOSE AND CHARACTER OF NEW EXPERIMENTS.—A promising field for still further improvement in turpentining methods was opened by the likelihood that by diminishing the wound caused by chipping the injury to the tree might be still further reduced without decreasing the yield. The problem is essentially to discover the effect of chipping on the physiological activities of the tree, upon which depend the secretion and flow of resin. To test this matter experiments were begun on March 1, 1905, with four crops of approximately 8,000 trees each.

These experiments are being conducted on a longleaf pine tract near Greencove Springs, Lake County, Fla., about 30 miles south of Jacksonville. The work is under the constant observation of the most progressive turpentine operators, a number of whom have already modified their methods in the light of such conclusions as the work itself has suggested, even at its present early stage.

The special thanks of the Forest Service are due to the Hilman-Sutherland Land Company, of Jacksonville, Fla., for the disinterested cooperative arrangement under which these experiments are being carried out. It is planned to continue the work for the regular commercial period of three years.

SYSTEMATIC STUDIES OF FOREST FLORA.

REGIONAL STUDIES.

The preparation of material for a series of bulletins descriptive and illustrative of the tree species of the different regions of the United States has been undertaken. The first installment of this work will be published, when ready, under the title of "Part I. Trees of the Pacific States."

FOREST HERBARIUM.

Response to the demands for technical information about trees made by individuals and by schools, colleges, and other institutions has become a considerable part of the duties of the Dendrologist. To facilitate this work the assignment of about 1,000 of the Forestry Division's original collection of tree, seed, bark, and wood specimens was secured. This material is needed not only for reference, but also to supply models for drawings to illustrate proposed studies of the tree floras of the United States.

FOREST LIBRARY AND PHOTOGRAPHIC COLLECTION.

By a change of quarters of the forest library and the photographic collection made in November, 1904, better facilities for practical use and enlarged space for filing books and photographs were gained. Adequate room for readers, however, is still lacking. Books and pamphlets to the number of 3,851 were added during the year, bringing the forest library to a total of 8,078 volumes. This marked increase is due mainly to a large accession of books and pamphlets previously in the Department library, for which the shelves of the Forest Service did not formerly afford space.

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The use of the library was markedly greater this year than last. Monthly announcements of all new forest literature received are regularly and prominently posted on the Service and library room bulletin boards. The library committee is now preparing for publication, in cooperation with the general library of the Department, a classified list of forest literature.

FOREST PHOTOGRAPHS AND LANTERN SLIDES.

The photograph collection contains 19,052 photographs, of which 5,192 were catalogued and filed during the past year—808 more pictures than were added during the previous year. The total collection comprises pictures from 43 different States and Territories and 9 foreign countries.

Lantern slides in the collection number 2,881, of which 561 were added during the year.

Duplicate photographs (mainly unmounted) to the number of 4,137 were given to 47 educational institutions, to 52 applicants for illustrations to be used in books and articles on forest subjects, and to 39 individuals who had extended assistance and courtesies to members of the Service doing field work, or were exchanged for sets of views from 4 foreign countries. Selections of lantern slides, numbering in all 1,861, were loaned for educational purposes.

As an aid to filling gaps in the collection and to prevent duplication, a map was prepared showing by counties the number of photographs already filed.

EXPOSITIONS.

The exhibit described in the last report of the Forester was displayed at the Louisiana Purchase Exposition until its close, November 1, 1904, when most of the material was safely returned to Washington. A few articles were shipped to Portland, Oreg., in anticipation of use at the Lewis and Clark Centennial Exposition; a large glass case and contents, illustrating methods of turpentining, was loaned to the museum of the College of Pharmacy, St. Louis, Mo., and all of the living trees and nursery stock, comprising the outside tree-planting exhibit, were presented to the Missouri Botanic Garden, St. Louis.

For the Lewis and Clark Centennial Exposition a practically new exhibit of the Forest Service was prepared. This was installed, together with the exhibit of the Reclamation Service, in a special Government building. Approximately 5,600 feet of floor and wall space was devoted to the forest exhibit. The two displays were planned to show clearly the direct and vital relationship between the fields of the two organizations, which, especially in the West, work hand in hand to secure, in the interest of the people at large, the wood and water resources of the country against waste and monopoly. The forest exhibit was ready and open to the public on the opening day of the exposition, June 1, 1905. The cost of preparing and installing it was approximately $7,600. Large colored and uncolored transparencies and colored bromide photographs effectively illustrated forest conditions and problems and the work of the Forest Service throughout the country. Maps, charts, instruments, models, wood specimens, and a timber-testing machine in operation were also

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important parts of the display, and helped to make it altogether the most successful and instructive portrayal of the whole field of forestry and its bearing upon public and private welfare which has ever been made in the United States.

WORK OF THE ENSUING YEAR.

The experiments in methods of turpentining already outlined will be continued on the lands of the Hilman-Sutherland Land Company, in Florida. The study of basket willows will also be continued, with special reference to the effects of different kinds of soil and of its moisture content upon the quality and quantity of rods produced, and to the behavior of newly imported European willows under the influence of strange soils and acclimation. In the studies of special groups and species of trees the Monterey pine and cypress will be added to the list of little-known desert pines of California already under investigation, the promised study of *Cascara sagrada* will be begun, and the brown-wooded junipers of Texas will be taken up. The study of certain kinds of acacias and eucalypts will be continued. In the regional studies of North American trees the preparation of Part I, Trees of the Pacific States, will be pressed forward, and that of Part II, Trees of the Rocky Mountain States, will be begun.

EXPENDITURES.

The total expenditures for the year under the head of Dendrology were $15,086.44, or 3.5 per cent of the total appropriation for the Forest Service.

FOREST PRODUCTS.

During the present fiscal year it became plain that a complete reorganization of the lines of work comprised under the head of forest products was needed. In consequence of the rapid expansion of this work, the aggressiveness with which problems of great magnitude had been attacked, the multiplication of stations, the extension of field work, and the failure of the office organization to keep pace with it, the need for better control and a firmer coordination of parts became imperative. To accomplish this work Mr. William L. Hall, previously the Chief of the Office of Forest Extension, was put in charge.

The investigations in progress at the beginning of the year were chiefly of two kinds—studies of wood preservation and tests of the strength of timbers. The wood preservation studies were grouped into three sections—Eastern, Central, and Western—with a central office in St. Louis, from which they are directed. The timber-test work was conducted at Lafayette, Ind.; New Haven, Conn.; Berkeley, Cal., and Washington, D. C., and was directed from the laboratory at Lafayette, Ind. A section of dendro-chemistry was also maintained, with headquarters at St. Louis, chiefly to assist and supplement the work in wood preservation.

On January 1, 1905, the reorganization of the office began. The system of handling cooperative funds was changed entirely. Accounts were submitted for all such funds expended during the first half of the fiscal year, and all balances in the hands of the field men

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were turned over to an agent of the Forest Service duly appointed to receive and disburse them, with the provision that all subsequent payments of cooperative funds must be made direct to this agent. The headquarters of the wood preservation and dendrochemical work were changed to Washington, and the three sections of wood preservation were combined.

The main energies of the office are now directed toward two ends—the finishing of much incomplete work left over from the previous year and from the early part of the present year, and the development of an adequate organization for handling the extensive and diversified work which the Forest Service must take up looking toward the economical use of wood. The present organization recognizes three sections—wood preservation, timber testing, and dendro-chemistry.

WOOD PRESERVATION.

COOPERATIVE RAILROAD WORK.

Several extensive lines of cooperative work with railroad companies, in progress at the beginning of the year, have for the most part been completed. In all cases the companies contributed to the expenses of the field work incident to the investigations.

(1) In cooperation with the Atchison, Topeka and Santa Fe Railway there was made an extensive study of seasoning and preservative treatment of tie timbers in New Mexico and Texas. The company has now adopted throughout its system the policy of preservative treatment for tie and bridge timbers. The field work with this company closed in May, and a report on the results was completed.

(2) An investigation to determine the best methods of handling and treating lodgepole pine, red fir, and western yellow pine was made in cooperation with the Chicago, Burlington and Quincy Railway. This work also was completed. It resulted in the adoption by the Burlington Railway of the policy of treating with zinc-chloride all of the above-mentioned kinds of ties. A report on the results of seasoning and treating lodgepole pine was prepared.

(3) The St. Louis and San Francisco Railroad assisted in investigating methods of handling and treating red oak tie timber.

(4) With the Northern Pacific Railway an investigation of methods of handling railroad ties of red fir was made. Seasoning experiments at Tacoma and Pasco, Wash., and Sandpoint, Idaho, are still in progress.

(5) A cooperative study of methods of seasoning red oak, beech, and gum in Tennessee and Mississippi, carried on with the Illinois Central Railroad, was practically completed at the close of the fiscal year.

In cooperation with the Chicago and Northwestern Railway a series of tie-seasoning experiments with hemlock and tamarack is being conducted. This is the most carefully designed experiment in the seasoning of timber which the Forest Service has undertaken.

Other experiments on tamarack ties are being conducted in cooperation with the Wisconsin Central Railway. This work opens a large field of usefulness in the Lake States.

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COOPERATIVE TELEPHONE POLE WORK.

During the past year the American Telephone and Telegraph Company and the Postal Telegraph Cable Company have assisted in work having for its object the determination of the best methods of handling and treating telephone and telegraph poles. Several hundred poles of chestnut and juniper were cut and carried through a full year of seasoning at Dover, N. J., Thorndale and Paoli, Pa., and Pisgah and Wilmington, N. C. Separate lots of these poles were then treated with several different preservatives. The treated poles, carefully numbered and labeled, have now been set in an experimental section of the line of the American Telephone and Telegraph Company between Savannah and Meldrim, Ga. Each treated pole is set between a green and a seasoned untreated pole for comparison.

Special open treating tanks were designed by the Service to permit of the treatment with creosote of 30-foot poles. So far as is known, this is the first apparatus constructed in the United States for impregnating the butts of telephone and telegraph poles. It was used with entire success.

A report on the seasoning and treating of telephone poles is now under way.

EXPERIMENTAL TREATING PLANT AT ST. LOUIS.

A special appropriation of $10,000 made it possible to carry on at the Louisiana Purchase Exposition experiments in the use of creosote as a preservative. Experiments were made to determine whether cheap and quickly grown timbers like cottonwood, willow, elm, and maple could be made durable enough for fence posts by creosoting. The treatments were made in an upright tank with heat applied direct. The work was too brief to be conclusive, but gave the best indications of success.

A second series of experiments was on loblolly pine and red oak cross-ties, to determine how these important and abundant timbers can be most economically treated. Both were found readily capable of treatment, and both, when treated, are fully satisfactory for ties. In connection with these treatments a series of tests on loblolly pine, to determine the effect on the strength of wood both of the preliminary steaming process and of the preservatives (zinc chloride and creosote) themselves, gave definite results. A complete report is to be submitted.

DENDRO-CHEMISTRY.

A large part of the work was the determination of the amount of zinc in timbers treated by the zinc chloride process. Analyses in the St. Louis laboratory of borings or sections of treated ties from all points in the field where treatments have been carried on gave most valuable results. A method of analysis was worked out which is recommended for general adoption, and a report setting forth this method was prepared.

Much attention was given during the year both to the examination of various coal-tar creosotes and to the methods of analysis for such creosotes. With the increasing use of coal-tar creosote for preserving timbers, the necessity for some standard method of determining its

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character has made itself felt with increasing force. A method was developed which it is believed will be widely adopted for the analysis of coal-tar creosote, and a report upon it was prepared.

TIMBER TESTS.

The work in timber testing during the past year has progressed toward a closer relation to other work in forestry, especially toward serving the interests of conservative forest management by showing the structural value of rapid-growth timber. Progress has also been made in promoting the use of preservatives by studying their effect on the strength of timbers and in studying the means by which preserved railroad ties can be protected against the abrasive action of traffic. Other useful work has been done in determining the mechanical properties of proposed substitutes for timbers like white oak and hickory, supplies of which for vehicle construction are rapidly disappearing; in supplying data which will enable more satisfactory and more accurate rules to be drawn up for the grading of structural timber; in supplying information on the technical properties of unfamiliar woods; and in placing on a scientific basis the technique of the methods of testing timber.

The Forest Service now has a well-organized system of laboratories and a trained staff of testing engineers. As yet, however, only a beginning has been made on a few timbers, such as longleaf and loblolly pine and red fir, but the greater part of the problem has not been touched.

The work of the year may be summed up as follows:

At the Yale laboratory a bulletin entitled "The Effect of Moisture on the Strength and Stiffness of Wood" has been prepared, based upon a long series of tests. The study will serve to establish correct methods of thinking on many fundamental matters in wood technology.

The tests on red gum collected from Missouri and from Alabama were, with the exception of certain tests on air-dried material, completed, and the results were published.

At the laboratory at Berkeley, Cal., preliminary tests of the mechanical properties of red fir collected from Washington, Oregon, and from the San Francisco market, and tests of western hemlock collected from Washington and Oregon were completed. The tests of western hemlock have given this timber the right to appear in the market on its merits.

The laboratory at Washington, D. C., completed a preliminary study of the mechanical properties of loblolly pine and longleaf pine. Already the results have aided manufacturers in the introduction of these woods in foreign markets. With the tests on red fir they have been of direct service to the Isthmian Canal Commission. They are now being continued at Charleston, S. C.

These various tests produced not only figures on large sticks for structural purposes useful both to engineers and to lumbermen, but also data which will result in the formulation of rules for determining the effect of various kinds of knots and other defects, and of the various rates of growth on the strength of timber.

A preliminary publication, entitled "Progress Report on the Strength of Structural Timbers," served a useful purpose. Various

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addresses and lectures were given at engineering associations and universities throughout the year. Exhibits showing the actual results of timber tests and actual test pieces of various species were prepared for the exhibit of the Forest Service at the Lewis and Clark Exposition at Portland.

A carefully planned series of tests was made to determine the relative value of various kinds of lumber for the making of boxes, in which the ability to hold nails, as well as the actual strength of the lumber, is involved. At the request of the Chief of the Philippine Bureau of Forestry, a report was prepared on the strength of four species of wood from the Philippine Islands.

Tests were made to determine the spike-holding capacity and the mechanical strength of certain specimens of *Catalpa catalpa* and *Catalpa speciosa*, and of treated red oak.

An investigation of the effect of the rate of loading upon the strength of wood is well under way at the laboratory of the Yale Forest School. It should have, when completed, nearly the same technical value as the work done by that laboratory on the moisture-strength problem.

In connection with the timber-testing plant at the Louisiana Purchase Exposition, a long series of tests was made on loblolly pine to determine the effect of steaming and of preservatives on strength.

The work of the various laboratories has included not only the collection, description, and testing of material, but the computation of the data, analysis of results, and preparation of charts to show conclusions—work which takes at least as much time as the tests themselves. The data not only serve the immediate purpose for which the tests were designed, but will form the basis of replies in a rapidly increasing correspondence from lumbermen, contractors, and engineers.

In all, 8,210 mechanical tests were made during the year, and an equal number of moisture determinations. Each test involves on the average about thirty-five measurements in addition to the description and drawing of the stick before and after the test.

ORGANIZATION AND WORK FOR THE ENSUING YEAR.

The office during the next year will comprise the four sections of lumber trade, timber tests, wood preservation, and dendro-chemistry.

LUMBER TRADE.

A section of lumber trade is being organized to study the supply, transportation, markets, and use of lumber and other forest products.

LINES OF WORK.

GRADING SPECIFICATIONS.—A preliminary study of specifications was made and the work is now being planned in detail, not so much for the purpose of suggesting modifications of present rules as to bring various specifications together for comparison by both buyers and sellers of lumber, just as has been done already in the case of log rules.

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STATISTICS OF MANUFACTURE.—Heretofore a decennial census of the lumber industry has been taken by the Bureau of the Census. Congress has provided for a quinquennial census, beginning with the year 1905. There is great need for a yearly statement of the amount of lumber cut and marketed, and the Forest Service will attempt to make such a statement, beginning with the cut of the year 1905. The work will be conducted principally by correspondence, after the methods followed by the Geological Survey in obtaining yearly statistics of the mineral products. The National Lumber Manufacturers' Association and other associations will cooperate with the Service in getting and publishing the figures.

STUDIES OF WOODS FOR SPECIAL USES.—Plans are ready for the study during the present year of cooperage and box woods, vehicle and implement woods, and wooden paving blocks. Similar studies are planned upon furniture and cabinet woods, railroad ties, fence posts, and piles and poles.

TIMBER TESTS.

The testing of timbers of commercial use will be carried on by a system of laboratories, with a central laboratory and office at Lafayette, Ind., as at present, or at Washington, D. C. The proposed system embraces six laboratories, whose location and work are as follows:

PURDUE LABORATORY, LAFAYETTE, IND.—Tests of the effects of preservatives and preservative processes on the strength of loblolly pine, tests of box lumber, tests of red gum which has been air seasoning for nearly two years, the study of the methods of testing wood for their properties of resisting abrasion, the determination of the ability of various woods to resist the action of a blow, showing different classes of defects, and determination of the mechanical properties of the possible substitutes for the hard woods now used in the vehicle industry.

A study will be made of the proper design for two new testing machines, the first to be a large machine of great capacity for testing the strength of posts or columns, for which now no machine exists, and the second to test the life of wood under such vibrations and repetitive stresses as come on stringers and other structural forms under the passage of a rolling or live load.

WASHINGTON LABORATORY, WASHINGTON, D. C.—Tests of loblolly pine for structural purposes, including the effect on strength of knots, air seasoning, kiln drying, rate of growth, sapwood, and age, and tests of the structural value of various hard woods of the southern Appalachians, and of the value of loblolly and shortleaf pine for cross arms.

YALE LABORATORY, NEW HAVEN, CONN.—Tests of the effect of the rate of application of a load on the strength of wood, and a study of the effect of different methods of drying on the strength of wood.

BERKELEY LABORATORY, BERKELEY, CAL.—Tests of western yellow pine as a structural timber and for telephone and telegraph poles and railroad ties, and of eucalypts, especially blue gum and red gum.

EUGENE LABORATORY, EUGENE, OREG.—Tests of various grades of red fir for structural purposes, and of cedar for telephone poles.

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SEATTLE LABORATORY, SEATTLE, WASH.—Tests of western hemlock for structural purposes, and of western spruce, western hemlock, and other timbers of the North Pacific region for cross-ties and telephone poles.

At all points the organization for the timber-test work will be alert to come into touch with the consuming interests of the country, in order to promote the use of inferior timbers in the place of rare and expensive ones, the economy of material, and the general interests of forestry.

WOOD PRESERVATION.

Probably not more than 10 per cent of the ties laid for renewal in the United States are treated. Yet railroad engineers almost unanimously agree that treatments must be applied generally within the next decade. And the variations in climatic and other conditions will make it necessary to adopt different processes of treatment in different parts of the country. Evidently the time is at hand for the fullest study of the problem. The facilities now available are inadequate for a thorough study of the subject. It is therefore proposed to establish a treating plant at Washington, D. C.

The question of handling timber to secure the maximum benefits of preservative treatment includes questions like the effect of the time of year of cutting, the effect of soaking, the effect of various forms of piling, and the effect of air seasoning. It is planned to conduct experiments on poles or ties, or both, of chestnut, northern white cedar, southern white cedar, western red cedar, eastern tamarack, southern cypress, and western yellow pine.

As a part of its work in wood preservation the Service will test the effect of paints and other applications which are applied externally to wood to preserve it. Another subject of great importance is that of methods of kiln-drying lumber. The present practice is admittedly ineffectual in many cases. A preliminary study of this problem is already under way.

DENDRO-CHEMISTRY.

The dendro-chemical work which the Service has previously conducted at the laboratory of the Missouri Botanical Garden closed at the end of the year. The study of chemical problems connected with the utilization of wood products will be conducted temporarily at a laboratory at New Haven, Conn., in cooperation with the Sheffield Scientific School of Yale University. The work to be taken up has the possibility of high value, and the search for suitable woods for pulp, the study of ways to utilize the present enormous sawmill waste, the improvement of processes of wood distillation, and the analysis of wood preservatives and of treated woods will be carried forward.

In view of the open field for this work and of the dependence of the general public and business interests upon the Forest Service for the solution of these and kindred problems, there will be established in Washington during the next year a laboratory with adequate equipment to handle the work.

EXPENDITURES.

The expenditures under forest products amounted to $56,881.22, or 13¼ per cent of the total appropriation.

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RECORDS.

SECTION OF ACCOUNTS AND SUPPLIES.

Upon the transfer of the forest reserves on February 1 it became necessary to appoint a special fiscal agent to be custodian of the funds derived from the sale of their products. In order to simplify the handling of this money the same officer was later made disbursing officer for the Forest Service, thus avoiding delay in the transmittal of accounts and in auditing and making payment, and reducing the amount of bookkeeping. Salary, reimbursement, and miscellaneous vouchers are now audited and paid in the Forest Service.

On February 1 arrangements were also made for the disbursement of cooperative funds, which amount to about $2,000 a month, by the special fiscal agent. The manner of handling cooperative vouchers now conforms to the fiscal regulations of the Department in every particular. A system of cost keeping was introduced to secure a complete and detailed record of the cost of each study and project undertaken, and of the cost of administering each forest reserve.

PHOTOGRAPHIC LABORATORY.

The map-copying equipment was of effective service, especially in securing maps of the forest reserves. A new map case and a system of indexing maps on file were installed. Specific instructions for taking forest photographs were furnished the members of the Service, and other steps to improve the general standard of forest views were taken.

QUARTERS.

No considerable increase in the rental of office rooms has been made during the past year. Arrangements have been made for the occupancy of three rooms on the first floor of the Atlantic Building as storage rooms for instruments, field equipment, and office supplies, which permits the loading and unloading of shipments direct to and from the property rooms.

FILES AND FILING.

The system of filing correspondence was found satisfactory both in security and in economy of operation. A fireproof vault installed in the basement of the Atlantic Building at the beginning of the year provided a convenient and safe place of storage for valuable records.

CORRESPONDENCE.

During the year 65,861 official communications were received in the Forest Service, and 61,713 were sent out.

STENOGRAPHY AND TYPEWRITING.

The concentration in this section of stenographers not assigned to offices continued to show a marked gain in the amount and character of the work done. It has resulted in developing a corps of skilled stenographers and copyists capable of meeting with promptness the various needs of the Service. During the year 1,451 items

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of work were performed, involving 25,211 typewritten pages (including 3,797 pages tabulated), 43,143 mimeographed sheets, and an increased amount of miscellaneous work. In addition, 390 temporary details of stenographers were made to offices for a total of 1,960 days. The average number of stenographers and copyists assigned to this section was 14.

PUBLICATIONS.

There were issued during the year 20 new publications, with a total of 366,500 copies printed. The bulletins were: The Basket Willow; The Forests of Texas; The Forests of Hawaii; The Timber of the Edwards Plateau of Texas; Report on the Condition of Treated Timbers Laid in Texas, February, 1902; Forest Planting in Western Kansas; Chestnut in Southern Maryland; The Luquillo Forest Reserve, Porto Rico; Forest Conditions in Northern New Hampshire; Federal and State Forest Laws; and Report on an Examination of a Forest Tract in Western North Carolina. The circulars of information were: Exhibit of Tree Planting on a Model Prairie Farm at the Louisiana Purchase Exposition; Exhibit of Forest Planting in Wood Lots at the Louisiana Purchase Exposition; Exhibit of Forest Nurseries at the Louisiana Purchase Exposition; Progress Report on the Strength of Structural Timber; What Forestry Means to Representative Men; and Practical Results of the Cup and Gutter System of Turpentining. Three reprints of Yearbook articles were issued: The Attitude of Lumbermen Toward Forest Fires; The Determination of Timber Values; and Progress of Forestry in 1904. The Yearbook article Forest Planting and Farm Management will be reprinted by the Department in the form of a farmers' bulletin. There was also published the Report of the Forester for 1904. In addition, 200,000 copies of the Preliminary Report and Second Partial Report of the Public Lands Commission were printed.

During the year 28 press bulletins were issued, with a total circulation of 156,900 copies.

Reprints of 8 publications were made, to the total number of 71,000 copies.

On June 30, 1905, 9 bulletins and 1 circular were in the hands of the printer.

The mailing lists of the Service comprise: (1) A special list of libraries; (2) a list of representative newspapers; (3) a small foreign list of scientific and governmental institutions; (4) a special list of persons engaged in forest work in the United States; (5) a general list of persons interested in forestry.

The first four lists, which number 4,081 addresses, receive all publications as soon as they are available. Cards are sent to the general list giving notice of the appearance of bulletins, with brief descriptions of their contents, and to this list certain publications of general interest are sent without notice. Applications for bulletins made in response to the card notices are honored in the order of their receipt. During the year the general list was thoroughly revised, and an effort was made to increase it conservatively by including persons specially interested in forest preservation. This work will be continued during the ensuing year. The addresses on this list now number 15,197.

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A large extra list of persons interested in lumbering and woodlands, farmers, educators, and professional people in various lines is now being compiled. This list will be carefully classified and will be representative of all sections of the country. It will be used to distribute material of importance to certain sections and to particular classes of people, and in general to stimulate a widespread interest in forestry.

EXPENDITURES.

The expenditures for the year under the head of Records amounted to $90,881.98, or 22 per cent of the total expenditure of the Service. In this are included large items for such general expenses as supplies, instruments, rent, and printing, which are incurred, at least in part, in the execution of productive work, not in the routine maintenance of office administration.

The expenditures of the Office of the Forester for the year, including the examination of reserve boundaries, State forest studies, publications, etc., was $121,078.16, or 28½ per cent of the appropriation.

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REPORT OF THE CHIEF OF THE BUREAU OF SOILS.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 17, 1905.

SIR: I have the honor to transmit herewith a report upon the work of the Bureau of Soils for the fiscal year ended June 30, 1905.

Respectfully,

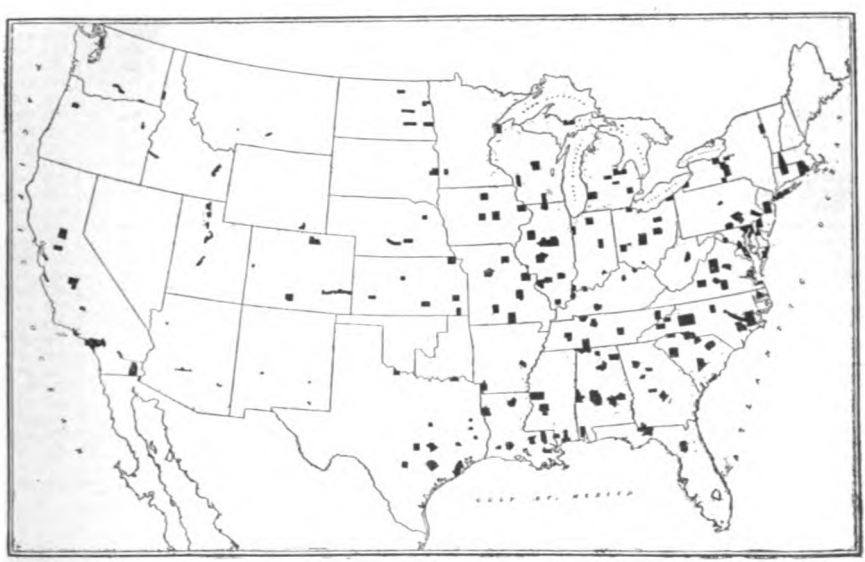
MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

PROGRESS OF THE SOIL SURVEY.

The area surveyed and mapped during the fiscal year was 24,613 square miles, or 15,752,320 acres. The area surveyed during the preceding fiscal year was 29,058 square miles. There have been



Areas covered by the soil survey to July 1, 1905.

completed to June 30, 1905, surveys covering a total of 99,408 square miles, or 63,621,120 acres, located in 45 States and Territories.

Work was undertaken during the fiscal year ended June 30, 1905,

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in 58 areas, distributed through 28 States. Rhode Island, a survey of which was begun in 1904, was completed during the period covered by this report, and this is the first survey of an entire State. Seventeen to twenty parties have been kept in the field continually, owing to the urgent demand for soil surveys. These parties have been shifted southward to the Gulf States in winter and distributed through the northern States, according to the demands of the work and the climatic conditions during the remainder of the year.

The areas surveyed and their respective costs are given in the following tables:

Areas surveyed and mapped during the fiscal year ended June 30, 1905, and the areas previously reported.

State or Territory.	Area surveyed during 1905.	Areas previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	3,244	3,619	6,863	4,392,320
Arizona	.....	611	611	391,040
Arkansas	.....	877	877	561,280
California	735	5,600	6,335	4,054,400
Colorado	777	1,573	2,350	1,504,000
Connecticut	.....	518	518	331,520
Delaware	.....	314	314	200,960
Florida	675	1,033	1,708	1,093,120
Georgia	203	1,610	1,813	1,160,320
Idaho	.....	1,135	1,135	726,400
Illinois	.....	5,925	5,925	3,792,000
Indiana	760	1,276	2,036	1,303,040
Iowa	.....	2,303	2,303	1,473,920
Kansas	882	1,463	2,345	1,500,800
Kentucky	533	837	1,370	876,800
Louisiana	1,180	2,388	3,568	2,283,520
Maryland	.....	2,663	2,663	1,704,320
Massachusetts	.....	796	796	509,440
Michigan	1,703	1,375	3,078	1,969,920
Minnesota	253	233	486	311,040
Mississippi	233	2,669	2,902	1,857,280
Missouri	1,753	2,030	3,783	2,421,120
Montana	.....	107	107	68,480
Nebraska	366	1,195	1,561	999,040
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	736	2,544	3,280	2,099,200
North Carolina	1,285	5,333	6,618	4,235,520
North Dakota	583	1,242	1,825	1,168,000
Ohio	300	2,755	3,055	1,955,200
Oregon	.....	446	446	285,440
Pennsylvania	774	1,204	1,978	1,265,920
Porto Rico	.....	330	330	211,200
Rhode Island	585	500	1,085	694,400
South Carolina	811	3,191	4,002	2,561,280
South Dakota	.....	485	485	310,400
Tennessee	903	2,143	3,046	1,949,440
Texas	3,182	4,297	7,479	4,786,560
Utah	201	1,300	1,501	960,640
Vermont	.....	227	227	145,280
Virginia	935	3,403	4,338	2,776,320
Washington	170	510	680	435,200
West Virginia	215	39	254	162,560
Wisconsin	636	955	1,591	1,018,240
Wyoming	.....	309	309	197,760
Total	24,613	74,795	99,408	63,621,120

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Areas surveyed and mapped and cost of field work during the fiscal year ended June 30, 1905. [a]

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Alabama	Blount County	625	$4.55	$2,841.70
Do	Dallas County	998	2.47	2,465.06
Do	Lauderdale County	708	2.64	1,872.00
Do	Montgomery County	780	2.31	1,802.14
Do	Sumter County [b]	133	4.29	571.20
California	Sacramento [b]	214	6.40	1,369.74
Do	Stockton	521	4.89	2,549.76
Colorado	Grand Junction	90	9.66	869.40
Do	Greeley	687	2.56	1,760.22
Florida	Leon County	675	4.00	2,701.00
Georgia	Spalding County	208	3.72	755.16
Indiana	Marshall County	445	1.71	762.96
Do	Newton County	315	2.36	743.40
Kansas	Allen County	504	1.72	868.68
Do	Brown County	378	1.84	695.52
Kentucky	Warren County	533	1.37	731.90
Louisiana	De Soto Parish [b]	325	3.06	993.24
Do	East Baton Rouge Parish	451	2.73	1,231.82
Do	Tangipahoa Parish	404	3.17	1,280.68
Michigan	Alma	282	2.30	648.00
Do	Munising	407	2.28	928.00
Do	Owosso	270	2.73	736.92
Do	Saginaw [b]	744	1.99	1,482.00
Minnesota	Duluth	230	2.63	604.90
Do	Superior	23	1.71	39.40
Mississippi	Crystalsprings	283	5.06	1,178.98
Missouri	Crawford County	400	1.68	672.00
Do	Saline County	748	1.18	885.40
Do	Webster County	605	2.12	1,285.20
Nebraska	Kearney [b]	366	1.03	376.47
New York	Auburn [b]	336	3.78	1,270.00
Do	Dryden	400	2.12	849.45
North Carolina	Duplin County	824	2.34	1,930.72
Do	Perquimans and Pasquotank	461	3.94	1,816.75
North Dakota	Cando [c]	283	4.53	1,283.00
Do	Cooperstown [d]	300	2.49	748.00
Ohio	Dublin	300	2.05	615.00
Pennsylvania	Adams County	534	1.80	959.90
Do	Montgomery County	240	2.66	638.40
Rhode Island	State [b]	585	1.52	889.20
South Carolina	Lancaster County [b]	436	1.86	909.71
Do	York County	375	2.07	776.25
Tennessee	Henderson County	285	2.25	641.25
Do	Lawrence County	618	2.44	1,506.00
Texas	Anderson County [b]	242	2.44	591.66
Do	Houston County	1,200	2.16	2,597.30
Do	Lavaca County	1,000	2.48	2,480.00
Do	Lee County	240	2.46	590.40
Do	Waco	500	2.45	1,225.00
Utah	Bear River [b]	201	4.71	947.55
Virginia	Appomattox County	340	2.43	827.37
Do	Louisa County	240	1.77	424.80
Do	York Neck [b]	355	4.22	1,497.50
Washington	Island County	170	2.57	436.90
West Virginia	Upshur County	215	2.30	494.50
Wisconsin	Portage County	177	2.82	499.14
Do	Superior [e]	459	1.70	780.60
Total		24,613	2.59	63,829.17

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not cost of transportation to and from the area.

[b] The portions of these areas surveyed in the preceding fiscal year were given in the last report.

[c] Of this amount $300 was paid by the agricultural and economic geological survey of North Dakota.

[d] Of this amount $122.22 was paid by the agricultural and economic geological survey of North Dakota.

[e] This area includes a few square miles in Minnesota.

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RECAPITULATION OF SOIL-SURVEY WORK FOR THE FISCAL YEAR 1905.

Cost of field work	$63,829.17
Supplies and other expenses	2,434.52
Traveling expenses between areas	2,606.36
Total cost of soil survey	68,870.05
Paid by State organizations	422.22
Paid by Department of Agriculture	68,447.83
Area surveyed—square miles	24,613
Cost of work in field per square mile	$2.59
Transportation, supplies, and other expenses per square mile	$0.20
Average total cost per square mile	$2.80
Average cost to Department of Agriculture per square mile	$2.78

The cost of the field work has increased from $2.21 per square mile, reported last year, to $2.59 per square mile during the year just closed. The latter figure is equivalent to 4 mills per acre, or about 50 cents per farm for an average-sized farm, as reported in the census of 1900. The total cost per square mile to the Department for both field and office work connected with the survey, and including transportation between areas and all supplies, has increased from $2.42 per square mile, as reported in 1904, to $2.78 per square mile during the year just ended.

During the past year there has been an increasing demand by different localities, interests, and individuals for the location of soil-survey work where such interests or persons would be served. Wherever the magnitude of the interest involved would justify, the areas have been located according to the wishes of the people as expressed in these requests. In the interest of economy in the conduct of the survey, it has been necessary, however, to increase the size of the individual areas at the expense of the number of areas, so that as small a portion of the available funds as is possible may be expended in transportation between areas, and so that the funds thus saved may be expended in actual mapping. For this reason, larger, more compact areas are being mapped and fewer small areas can be mapped to serve special or local interests.

The necessity for a large number of small areas, widely scattered, is also decreasing because enough areas in the different parts of the United States have been mapped to place in the possession of the Bureau information requisite for a broad general classification of the soils into their larger groupings.

Thus the conditions in the Atlantic Coastal Plain, the Central Prairie belt, the region of the Great Lakes, and other grand crop divisions have been quite fully outlined, and the limits of the various natural soil and agricultural provinces of the country determined. From the data at hand a complete classification of the various soil series and types will be worked out for future guidance, not only in mapping other areas, but also to serve as a record of the crop conditions, methods of soil management, general and special adaptations of crops to soils, and adjustments of farm practice to modern economic conditions.

From the maps and reports made and contemplated, the kinds of crops best suited to given soils, climates, and conditions of transportation can be announced with increasing definiteness and accuracy. It is felt that under the modern tendency toward specialized and intensive business farming greater benefit can be derived by all communities from the reports and surveys of the various regions.

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The soil maps of the different areas are prepared upon the most accurate base map which can be obtained. The U. S. Geological Survey topographic maps, constructed upon a scale of 1 inch to 1 mile, are the most accurate maps to be found, and they are used wherever available. In order to secure uniformity in the soil maps of the Bureau, all other base maps, such as county atlas maps, plane-table surveys, and others, are made to conform to this scale.

Upon a map having a scale of 1 inch to the mile, all houses, roads, streams, topographic differences, and general cultural features can be set forth without confusion, and the soils can be mapped with such accuracy that only minor variations need be omitted. Attention is called to these in the text of the report.

The unit of mapping is 10 acres, and all soil differences of larger magnitude are indicated, together with many of less size. Greater accuracy is being attained in this respect with the improvements in method secured by longer service of the men employed and by their increase in skill, both in detecting and representing soil changes. Similarly with the enlarged knowledge of general conditions derived from the extension of the surveys, the work of accurate identification and correlation of identical types of soil in widely separated areas is secured. The forthcoming general classification of the soils of the United States will also aid in further improvement.

The demand for the soil-survey reports, and for the separates and maps covering special areas, shows not only an increase in the number of individuals who are depending upon information secured by the soil survey, but it also shows an increasing number of business lines and occupations interested in the results of the work.

In addition to the many individual home seekers who desire to be informed of the soils, the climate, the agricultural conditions, and the market facilities which may be furnished by areas where they desire to settle, there are numerous applications for survey reports sent in by transportation companies interested in the development of agricultural territory tributary to their lines. These applications come not only from partially settled areas, but also in large numbers from such States as New York, Virginia, and North Carolina, where special industries, such as market gardening, trucking, fruit raising, and dairying are being put upon a more intensive footing.

The maps and reports are constantly in use by real estate men, brokers, loan agents, and investment companies for land-sale purposes and for investments at distances of 100 to 500 miles from the home offices. Some companies report that customers will buy only after securing the soil maps of areas in which they are interested. This is particularly true in the truck region from Long Island, New York, to Norfolk, Va.

One life insurance company reports using the soil maps to equalize life risks, "since they note that certain diseases may be rather generally associated with certain soils and regions."

Several scientific surveys conducted by experiment stations, universities, and scientific associations have used the soil maps for a basis of their work during the past year. In New York the "Apple Orchard Survey of Wayne County" used the Lyons sheet. In Nebraska the "botanical survey" is using the published sheets and asking for additional surveys. In Iowa the State forester is making

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use of the survey maps. In Colorado the State irrigation engineer is using the maps and the reports on the water supply, irrigation, and alkali. In Illinois the maps are used for botanical surveys. These uses are all in addition to the regular and normal use of survey reports and maps for purposes of instruction. Many hundred copies of separates and of the annual reports have been furnished to the instructing staff and to students in geology and agriculture in many leading universities.

The applications received from individual farmers and investors are steadily increasing in number, and in several instances the receipt of soil maps and reports has been followed by requests for information as to the correct method of producing crops recommended for the various soils of the area covered. These are all referred to the proper officials.

Among the special crops and industries which have been served by the sending out of soil maps and reports during the past year may be mentioned: Tobacco in New England, North Carolina, Florida, Alabama, Texas, Ohio, and Wisconsin; truck crops in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Florida, Mississippi, and Texas; sugar beets in New York, Michigan, and Wisconsin; apples in New York, Virginia, North Carolina, Illinois, Missouri, Arkansas, Indian Territory, Oregon, and Washington; alfalfa in nearly every Eastern State, particularly in Vermont, New York, New Jersey, Virginia, and North Carolina; canning crops in New York, New Jersey, and Maryland; rice in South Carolina, Mississippi, Louisiana, and Texas. Nearly every State in the Union has made inquiries regarding its special adaptation of crops to soil, and a general awakening to the varied soil resources of the country, coupled with renewed interest in the lands of the older settled States, has been evinced by the requests for soil maps and the location of new surveys.

Applications for soil surveys are on hand and awaiting action in sufficient number to require the continued employment of the present field force for over five years.

Such a general demand would seem to indicate not only a widespread interest in the survey work but also a definite and special value recognized in all quarters by a very diverse set of interests. The determination of the American people to develop all of their agricultural resources fully is evinced by the constant stream of inquiries from all quarters for definite information regarding the soils of the country.

The extent to which the soil-survey maps and reports are used can best be shown by citing the figures giving the distribution of advance sheets from the office of the Bureau of Soils. It should be understood that these figures do not include either the distribution of the annual reports or of the copies printed for use within the Congressional districts where the surveys have been made. These copies of single surveys have been requested by individuals in addition to the other distributions indicated above. Since the publication of the separate reprints of the various surveys made in 1902, there have been sent out on request a total of 14,954 of these reprints. Since the publication of the advance sheets covering the areas surveyed in 1903, there have been issued similarly a total of 21,051 of these sheets, or a grand total

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of 36,005 copies of these publications has been supplied directly to applicants by the office of the Bureau of Soils.

When it is remembered that each one of these copies has been issued in response to a direct request for a map and report on a specified area, it will readily be seen that the maps and reports are in constant demand.

The reports requested are not confined to any particular section, but show a remarkably even distribution over the entire United States. Nor are the requests received found to cover areas immediately surrounding the locality where the correspondents reside. In fact, most of the requests denote a purpose to ascertain facts concerning the soils and agriculture of regions distant from 100 to 200 or more miles away from the home of the person requesting information.

The demand has been heavy for maps of the principal trucking regions along the Atlantic and Gulf seaboards, for maps of areas where the fruit industry, particularly apple production, is being developed, for all areas where new lands are being opened for settlement, for those areas where new manufacturing industries are developing, with a consequent demand for various provision crops and dairy products, for surveys even in the older settled communities where agriculture is in its most flourishing condition. It is presumed that the chapters on "Agricultural methods and conditions" concerning such areas are desired fully as much as a precise knowledge of the soil types and the climatic conditions.

The Lyons, N. Y., area leads in the number of separates issued from this office, with Long Island, New York, and McLean and Clinton counties, Ill., almost equally in demand.

Of the 32 areas surveyed and reported upon in 1902, 11 areas have met with a demand for over 500 copies each. Of the 61 areas comprised in the work of 1903, 10 areas have already met a special demand of 450 copies, and no area mapped that year has met a demand of less than 100 copies, distributed to nearly as many applicants. Many of these separates, as has already been shown, go into the hands of chambers of commerce, of commercial clubs, of granges, of farmers' clubs, of professors who are using them to illustrate lecture work at the leading universities, and of real estate men and investment companies. In this way the information given by a single separate is widely disseminated, and each copy thus serves to inform many persons of the facts which it contains.

The particular object of the soil survey is to ascertain the exact characteristics of soil types as they occur in the field, with special reference to their adaptation to different crops. The great agricultural question is that of discovering the best methods for continually securing the largest crops at the smallest possible expense. As the field work has developed greater familiarity with American soil problems, the crop-producing question has been evolved into two coordinate and equally important phases. The first of these concerns the ability of soils differing in texture, structure, drainage, and climatic surroundings to produce the different grains, grasses, vegetables, and fruits. This is the crop adaptation problem, and its answer involves the reply to such specific inquiries as that concerning the best soil for raising a given crop in a specified region. There is also recognized the further question of the necessary and economic fertilization, tillage, and gen-

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eral soil management of each soil in order that it may attain to its full producing capacity. This latter problem is as urgent of solution as the former. For this reason there has arisen from the results of the field survey, which ascertains the local needs and methods, a correlated line of work for the study of soil fertility and soil management.

At present the specific fertilizer and management needs of the extensive soil types producing the staple crops of the country are being studied through newly devised methods founded on the recent discoveries of the Bureau concerning the fertility problem. Typical representative samples of soils to be studied are secured from fields whose history and producing capacity are well known. Samples are specially sought from fields or localities which are known to have produced good crops at some period, but which are no longer giving satisfactory results. These samples are referred to the force in charge of the soil management for experimentation, for study, and for the trial of specific methods of treatment.

The samples are subjected to the wire-basket method of crop culture outlined in Bulletin 23 of this Bureau, and since adapted to this special line of investigation. The effects of various fertilizing materials and of different methods of mechanical treatment are in this way compared with the results obtained from untreated soils, and specific conclusions can be reached in a comparatively brief time concerning the requirements of individual soils when called upon to produce the different crops. The results attained coincide with field observations upon the best modern practice of soil management as followed by the best farmers located upon the soil types and in the areas so far examined.

This work, coupled with the field study of crop adaptation carried on by the soil survey parties, enables the Bureau to make definite and detailed statements not only regarding the character of the crops to be raised on each soil type but also in regard to the manurial and cultural methods to be employed to secure satisfactory crops and adequate financial returns.

This work has just been developed, but, taken in connection with the soil survey work, upon the results of which it is largely based, it gives great promise for future recommendations of immediate and permanent value.

The demand made upon the Soil Survey for mapping areas has reached such a magnitude that the reasonable requests now on hand will require the constant field service of all the available men for at least five field seasons. Owing to the transfer of highly trained men to the Reclamation Service of the U. S. Geological Survey and to the alkali reclamation work of the Bureau of Soils the field force has been depleted until only 16 parties—32 men—are at present available. The needs of the service can be met only by maintaining the full field force at a strength of 20 parties—40 men—with 6 additional men available for the office work essential to the proper conduct of the survey.

On account of the nature of the field service and from the standpoint of economy it is necessary to keep the survey men constantly assigned to field work. Under existing conditions many of the men can be called to headquarters only at intervals of two and three years. The methods of soil study and the results obtained by the laboratory research upon the soil problems are subject to constant change, and

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the men who are absent from headquarters for long periods of time lose touch with the latest discoveries in soil science. In order that they may do the most effective and practical work, and that they may apprehend the full bearings of the vital soil problems which they are constantly encountering in the field, it is highly desirable that new means should be devised for maintaining closer relations between the field parties and the scientific staff engaged in research work in the Bureau laboratories.

In order to meet this requirement it is desirable to maintain 20 parties of 2 men each in the field. In addition, 6 members of the field staff should be detailed to service in connection with the Survey at headquarters. These men should be employed in the study of problems for which their field experience would especially fit them, upon the work of assisting in the careful classification and correlation of the soils of the United States, and upon office details of the survey work in such a manner that their comprehension of the field problems might be broadened. No one man would remain at the office for a period exceeding two or three months, and such assignments of men would follow in a succession sufficiently rapid to keep all of the men well in touch with the progress of soil investigation. Such assignments would be of almost as great a benefit to the laboratory force as to the field men more directly concerned.

With the increasing number of areas surveyed, and because of the constant occurrence of new types of soil, it has become necessary to make some additional provision for the inspection of areas while the field work is progressing. From three to five areas are completed each month in the year. The soils and agricultural conditions in each area must be studied, not alone in relationship to the needs of that area, but also as regards the broad problem of their relationship to other soils and to other agricultural areas. The men who are making the survey are not usually in position to give much time or thought to the general bearings of the facts which they ascertain. They must attend to local details. They can not be kept fully informed even of the concurrent work of the other survey parties nor of the new soil types encountered, nor of the new crop adaptations discovered. It is advisable, to meet the requirements of the soil classification and correlation, that two inspectors should be appointed to exercise a supervision over the field work of the various parties under the direction of the Chief of Bureau. These men should visit each area during the progress of the work and ascertain what soil types occur within the area, the relationship of these types to others previously mapped, and their local peculiarities of crop adaptation and of method of management. They should also make suggestions, both to the Chief of the Bureau, for his information, and to the men directly engaged in mapping, for their guidance, in regard to the requisite classification of soils newly encountered.

One of the men should be an expert in the problems presented by irrigated areas and by alkali conditions. The other should be especially well trained in the problems confronting the humid regions. He should be conversant with the best farm practice and with the special problems of crop introduction and crop specialization.

Such men are available in the force as it exists and would only need to be detailed for this special service, which is contingent only upon adequate appropriations.

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With the increase in the amount of field work which has occurred during the past few years there has been a corresponding increase in the amount of work which must be done by the clerk having charge of all matters pertaining to the maps of the survey. The present clerk in charge of this work has performed with marked ability and faithfulness for over three years the extensive duties devolving upon him. His duties include securing information regarding all county maps and atlases which may be needed as base maps; assembling the various parts as they are sent in by the field parties, and making the corrections for coloration, topography, and cultural features which have been indicated by the field men; preparing fair and exact copies of these maps for the engraver; receiving engraved proofs and comparing these with originals.

Upon the completion of the copy for the lithographer he measures the area of each soil type, in order that a careful record may be made of the extent and distribution of the various soils adapted to special and general farm crops.

In many cases the only maps available for use as base maps are found to be upon some unusual scale not conforming to present standards. These maps are replatted upon the standard scale and furnished to the field parties. All supplies pertaining to the map work are under his immediate charge.

All of this work calls for a high degree of technical skill, for constant application, and for a marked degree of personal good judgment. Many of the duties are of such a character that they can not be delegated to subordinates of a less degree of training. It would appear that work of such a character is deserving of pay adequate to the service rendered, and it is recommended that the position be made that of map clerk at $1,800 per annum. The clerical position, carrying a salary of $1,400, thus rendered vacant would become available for the appointment of an additional editorial clerk whose duties would be to assist in the proof reading of maps, reports, and bulletins. There have been published within two years sixty-one reports on areas mapped in 1903, forty-six reports on the areas of 1904, and about the same number of reports will be edited and published for the season of 1905. In addition, the editorial staff is called upon to edit all of the special bulletins and circulars of the Bureau. Since January 1, 1901, there have been published eleven bulletins, eight circulars, and several reprints and special reports covering the special work intrusted to the Bureau of Soils. All of these require the most careful proof reading and correction by a force familiar with the technical language and special requirements of this branch of scientific investigation. It would seem that an additional man should be put in training for this work. The appointment of such an editorial clerk to the position above mentioned is recommended.

BRIEF SUMMARY OF THE RESULTS OF THE SOIL SURVEY.

The following gives, very briefly, the results in the following States and areas:

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ALABAMA.

During the fiscal year the survey of Sumter County, which was begun in the preceding year, was finished and four other areas were completed.

Blount County (625 square miles) is situated in the north-central portion of the State. The topography consists of parallel ridges with intervening valleys. The soils have been formed from cherty limestones, sandstones, and shales; the limestones give stony, silty soils, the sandstones sandy loams, and the shales heavy loams. Cotton and corn are the principal crops. Considerable attention is given to stock raising and fruit growing, and it is believed that the soils are well adapted to the latter industry, which could be very profitably extended.

The soils of Dallas County (998 square miles) consist of the sands and the heavy loams of the Norfolk and Orangeburg series and the heavy clay soils of the Houston series. There are large areas of the Orangeburg fine sandy loam, a type upon which this Bureau has demonstrated that a good grade of Cuban filler tobacco can be grown. Dallas County is one of the largest cotton-producing counties in the State, and one-third of the cultivated land of the county is devoted to this crop. Corn is next in importance. The great variety of soils gives an opportunity for much greater diversification of crops than is practiced at the present time.

Montgomery County (780 square miles) lies in the Coastal Plain, and the soils are very similar to those found in Dallas County. The central part is crossed in an east and west direction by the limestone prairie soils. The northern and southern parts are covered by soils belonging to the Norfolk and Orangeburg series. The county thus possesses a great variety of soils. Cotton is the most important crop, and one-half of the cultivated land is devoted to it. Corn is grown quite extensively, but not enough is produced to supply the demand for home consumption. Greater attention should be given to the diversification of crops.

Sumter County has an area of 893 square miles, of which 133 square miles were mapped during the present year. It is situated in the western part of the State. The surface is moderately hilly and broken, with some level tracts in the prairie sections. As this county lies in the Coastal Plain, the soils are much like those of Dallas and Montgomery counties. Cotton is generally grown, while corn, oats, Irish and sweet potatoes, and miscellaneous vegetables are produced in considerable quantities. The production of truck crops has been materially increased during the last decade.

Lauderdale County (708 square miles) is the extreme northwestern county of the State. Five types of soil were recognized, three of which have been formed from underlying limestones that are very cherty in many places and give rise to large areas of stony soils. A large proportion of the county is covered by a silt loam, locally known as the "Barrens." The principal agricultural development is along the Tennessee River. The interior of the county is very thinly settled. Corn covers the largest acreage, while cotton and wheat are grown extensively.

The above-described areas, together with the areas heretofore surveyed, make a total area of 6,863 square miles covered by the soil survey in Alabama.

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CALIFORNIA.

The work in this State during the fiscal year consisted of the completion of the remaining 214 square miles of the Sacramento area and of an additional area around Stockton.

The Sacramento area, consisting of 924 square miles, lies within and adjacent to the southeastern portion of the Sacramento Valley. The soils exhibit great variety and complexity, and 17 different types were recognized. The climate is semiarid, but the winter rainfall is sufficient, with care and thorough cultivation, to mature many crops without irrigation. The grains are grown entirely without it. The area is free from serious alkali and seepage-water problems. In the valley portion of the area, wheat, oats, barley, and hay are the principal crops. In the foothills, upper-valley slope, and the valley plain immediately south of the American River table and wine grapes, peaches, plums, cherries, pears, apricots, and other deciduous as well as citrus fruits are produced in large quantities. Hops, berries, and small fruits are also important crops in the area.

A rectangular area, approximating 520 square miles, was surveyed around Stockton. The soils are generally of alluvial or lacustrine origin. Near the central and northern parts of the area a large amount of land is devoted to orchard and vine production; the eastern and southern parts are given mainly to the growing of grains and the raising of live stock. The western section covers extensive areas of reclaimed and unreclaimed "tule," or swamp, and overflow lands—famous for its dairy products, asparagus, vegetables, grain, beans, and potatoes. Irrigation was for many years considered unnecessary. While the greater portion of the area still remains unirrigated, the practice is becoming more common with the development of intensive agriculture. Only relatively small areas of alkali in injurious quantities exist. The lands most seriously affected occur in the southern and southeastern parts of the survey.

The total number of square miles surveyed in California, including areas previously reported, amounts to 6,335.

COLORADO.

A survey of an area around Greeley was made, and another one around Grand Junction was in progress during the year just closed.

The Greeley area, containing 687 square miles, lies at the eastern foot of the Rocky Mountains in the north-central portion of the State. The soils consist of both uplands and bottom lands, and, as a rule, are very productive. The climate of the area is semiarid, and practically all of the cultivated land is irrigated. The individual areas of alkali usually cover but a few acres, although the aggregate extent is considerable. The accumulation of alkali is due to the rise of seepage waters to the surface, and if these were disposed of it could be eliminated. The irrigated districts are for the most part devoted to general farming. A considerable portion of the river bottom soils is devoted to trucking and hay crops. Sugar beets, alfalfa, oats, and potatoes grow extremely well, while all crops adapted to the climate give good yields.

The total area covered by the soil survey in Colorado up to June 30, 1905, is 2,350 square miles.

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FLORIDA.

The only area surveyed in this State during the fiscal year was Leon County, containing 675 square miles. The soils of the northern half of the county belong principally to the Norfolk and Orangeburg series, and are very similar to those of Gadsden County, upon which shade-grown wrapper and Cuban filler tobacco have been successfully produced. This industry has recently been inaugurated in Leon County, and there is every reason to believe that it can be profitably extended.

This area, with those heretofore surveyed (Gadsden County and Gainesville area), makes a total of 1,708 square miles in this State.

GEORGIA.

In the survey of Spalding County, containing about 203 square miles, 4 types of soil were recognized. The Cecil sandy loam and Cecil clay cover over 90 per cent of the area. Cotton and corn are the most important crops, the former occupying 50 and the latter 40 per cent of the cultivated land. Some wheat and grass are grown, and, as the principal soils are strong, fertile, and well adapted to these crops, the acreage could be profitably increased.

This area, together with those previously surveyed, gives a total of 1,813 square miles covered by the soil survey in Georgia.

INDIANA.

One area was completed in Indiana and another (Newton County) almost finished during the fiscal year.

A survey was made of Marshall County (445 square miles), which lies in the north-central part of the State. The soils are of glacial origin and belong to the Marshall series; the Marshall loam and the Marshall sandy loam cover 70 per cent of the area of the county. The farmers have a fair understanding of the adaptation of soils to crops, but further suggestions are made in the report.

The total area surveyed in Indiana during the three seasons in which work has been done in this State amounts to 2,036 square miles.

KANSAS.

A survey of Allen County was completed and one of Brown County begun during the fiscal year. Owing to the approach of winter weather the survey of Brown County had to be suspended, but the area will be finished during the next fiscal year.

Allen County, comprising an area of 504 square miles, is situated in the southeastern part of the State. Nine types of soil, besides small areas of rough stony land and rock outcrop, were recognized. Fifty-six per cent of the total area of the county is covered by the Oswego silt loam. Corn is the crop most extensively grown, but the acreage of hay, oats, wheat, millet, and broom corn is being increased, especially that of wheat. The difference in the agricultural values of the different soil types and their adaptability to the different crops are pointed out in the report.

The total area covered by the soil survey in Kansas is 2,345 square miles.

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KENTUCKY.

A survey of one area (Warren County) was made in Kentucky during the fiscal year. This contained 533 square miles and included 5 types of soil. Of these, the Clarksville silt loam covers 68 per cent of the area of the county, while the Dekalb silt loam covers 26 per cent. Corn, tobacco, hay, and wheat are the principal crops. Many horses and mules are raised. More attention should be given to the adaptation of soils to crops and to systematic crop rotation.

With the areas already surveyed, this makes a total of 1,370 square miles covered by the soil survey in Kentucky.

LOUISIANA.

The survey of De Soto Parish, which was in progress at the end of the last fiscal year, was completed, and surveys were made of East Baton Rouge and Tangipahoa parishes.

East Baton Rouge Parish comprises an area of 451 square miles, and is divided topographically into uplands and bottom lands. The bottom lands are covered by the soils of the Yazoo series, which are strong and fertile. The upland is occupied almost entirely by the Memphis silt loam. About one-third of the parish is under cultivation, and this is principally in the western part. More than one-half of the cultivated area is devoted to cotton.

Tangipahoa Parish covers about 404 square miles and is situated in the southeastern part of the State. The extreme southern part is occupied by swamps and marshes; north of this lie the level, gray silty pine lands, while the northern part is rolling and hilly. Except along the railroad, the parish is largely undeveloped. Cotton and corn are the important crops. Along the railroad much attention has recently been given to trucking, and the parish is rapidly developing this industry.

De Soto Parish comprises an area of 825 square miles, of which 325 square miles were mapped during the past year. It is situated in the northwestern part of the State. In the survey of this area 10 different types of soil were mapped. The Norfolk fine sandy loam covers 46 per cent of the area. Cotton is the one important staple and is grown almost to the exclusion of subsistence crops, so that there is not much diversity in agricultural products. The one-crop system is gradually losing favor, because the farmers are beginning to realize that other crops can be profitably grown. The fruit industry is being developed quite extensively in some sections of the parish and is proving quite profitable. The light soils are admirably adapted to trucking and market gardening, which industries should be introduced for the sake of diversifying the agriculture of the parish.

The total area surveyed in this State, including areas already reported, amounts to 3,568 square miles.

MICHIGAN.

In addition to the completion of the Saginaw area, of which 240 square miles were already surveyed, three areas were mapped in Michigan during the fiscal year.

The Saginaw area, comprising 984 square miles, has a great diversity of soils; 17 types belonging principally to the Clyde and

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Miami series were recognized; 52 per cent of the area is covered by the Clyde loam and the Clyde sandy loam, two of the most important sugar-beet soils in Michigan. The survey was made principally to determine the adaptability of the different soils to the growing of this crop. Some of the types were found to be adapted to the sugar beet, while others were not. This is brought out in the report.

The Alma area, containing 282 square miles, is situated southwest of the Saginaw area and has very similar soils. The larger part of the area is covered by the Miami soils; 41 per cent, however, is covered by the Clyde loam and the Clyde sandy loam, which, as stated above, are well suited to sugar beets.

The Owosso area, containing 270 square miles, lies south of the Saginaw area. The survey shows 9 types of soil, 5 of which belong to the Miami series. The only member of the Clyde series is the Clyde loam, which covers 41¼ per cent of the area. The growing of sugar beets is a new industry in this area, but since there are large areas of the Clyde loam, the best of the sugar-beet soils in this section of the State, the industry can be extended.

The Munising area, comprising 407 square miles, is situated in the north-central part of the Upper Peninsula. The soils were divided into 8 types, though 63 per cent of the area is covered by the Miami sand. The area is still new agriculturally. The largest and most important crop is Irish potatoes, with hay next in importance. Sugar beets have been tried and promise to be an important crop. The soils are well adapted to fruits and vegetables, and the farmers are urged to take up their cultivation.

There has now been surveyed in this State a total area of 3,078 square miles.

MINNESOTA.

During the fiscal year an area of 230 square miles in Carlton and St. Louis counties was completed. This adjoins an area of 23 square miles previously mapped in Minnesota in connection with the Superior (Wis.) area.

The total area surveyed in this State, including previous surveys, amounts to 486 square miles.

MISSISSIPPI.

An area of 233 square miles was surveyed around Crystalsprings. The most important soil encountered is the Memphis silt loam. Considerable attention has been given to trucking, and this soil is well adapted to the kinds of truck grown.

The total number of square miles surveyed in Mississippi, including work previously done, is 2,902 square miles.

MISSOURI.

Two counties were surveyed in Missouri during the fiscal year and a survey of Crawford County is in progress at the time of the making of this report, 400 square miles of this county being completed.

Webster County, containing 605 square miles, is situated in the southwestern portion of the State, upon the crest of the Ozark uplift, and the country is hilly and broken. The soil is divided into 4 types, with small additional areas of Rough stony land and Riverwash.

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The two principal types are the Clarksville stony loam (55 per cent) and the Clarksville silt loam (38 per cent). The different types of soil are all adapted to different crops, and this point has been fully treated in the report upon this area.

Saline County, with an area of 748 square miles, is situated northwest of the center of the State. In the survey of this county 8 types of soil were mapped. Sixty-five per cent of the area is covered by the Marshall silt loam. This is one of the finest agricultural counties of the State, and 90 per cent is in farms. Corn is the most important crop, covering 40 per cent of the cultivated area of the county. Considerable wheat is grown, and a large amount of stock is raised.

These areas, together with those previously surveyed, give a total of 3,783 square miles mapped in this State.

NEBRASKA.

The only work done in Nebraska was the completion of the survey of the Kearney area, which was in progress at the end of the last fiscal year. Seven types of soil are shown upon the maps. Of these the Marshall silt loam covers 63 per cent of the area. West of Odessa there is an area in which much of the soil contains enough alkali to be injurious to crops, but the greater proportion can be reclaimed by underdrainage, and the proximity of the land to one of the trunk-line railroads would doubtless make this reclamation profitable. The principal farm products are corn, wheat, oats, rye, alfalfa, and sugar beets; and cattle raising and dairying are followed to considerable extent. The acreage of alfalfa is rapidly increasing.

The total number of square miles thus far surveyed in Nebraska is 1,561.

NEW YORK.

The work in New York during the last fiscal year comprised an area of 336 square miles in southern Cayuga County, around Auburn, and 400 square miles in Tompkins County. The latter area is nearly completed.

The Auburn area contains 9 types of soil, besides Muck and Meadow. Grass and grain production, dairying and fruit growing are the chief industries. The adaptation of crop to soil, crop rotation, and the introduction of special crops are understood and practiced in the area.

These areas and those previously reported constitute a total of 3,280 square miles mapped in New York State.

NORTH CAROLINA.

The work in this State, as in previous years, has been carried on in cooperation with the North Carolina department of agriculture, and three counties have been surveyed during the fiscal year.

The Perquimans-Pasquotank area (461 square miles) lies in the northeastern part of the State. The surface is level and the area includes a portion of the Dismal Swamp. Including Swamp, 7 types of soil are shown on the map. These soils belong to the Norfolk and Portsmouth series. Cotton, corn, peanuts, and truck are the principal crops. Only a small area, however, is devoted to trucking. The adaptability of the soils to this industry is brought out in the report, and it would seem that it could be very profitably extended.

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Duplin County, containing 824 square miles, is situated in the southeastern part of the State. The soils here are very similar to those in the Perquimans-Pasquotank area. As this county is farther south, more cotton is grown. The special industry of growing tuberose bulbs has been more largely developed in this county than in any other place in the world. The soils are well adapted to truck-ing, and this industry is being extended. These three counties, together with areas previously surveyed, give a total of 6,618 square miles surveyed in North Carolina.

NORTH DAKOTA.

The Cando area was completed during the fiscal year, and work on the Cooperstown area is now in progress. This work was carried on in cooperation with the agricultural and economic geological survey.

The Cando area, embracing an area of 283 square miles, lies in the northern part of the State. Five types of soil were recognized. The soils, which have been formed either directly from glacial material or by the reworking of such material, contain a large percentage of organic matter and lime. Some alkali was encountered, but with proper care no serious trouble is anticipated from this source. The area is located in a newly developed agricultural section. The four crops, wheat, flax, oats, and barley, in 1900 occupied 99 per cent of the area cultivated. Some durum wheat is produced, and this variety is growing in favor.

Of the Cooperstown area, 300 square miles had been completed by the end of the fiscal year.

The total area, including the above and those already reported, amounts to 1,825 square miles surveyed in North Dakota.

OHIO.

A survey of an area adjoining the Columbus area on the north was begun May 1, and, on June 30, 300 square miles had been completed. This area will be completed by the 1st of August.

The total area surveyed in this State to July 1 was 3,055 square miles.

PENNSYLVANIA.

The work in Pennsylvania during the fiscal year comprised the survey of Adams County and 240 square miles of Montgomery County. The remainder of the latter county will be surveyed during the early part of the next fiscal year.

The soil of Adams County (534 square miles) was classified into 14 different types, varying in texture, topography, and agricultural value. The prosperity of the farming class bears a close relation to the soil types upon which the farms are located. The farmers living upon the limestone soils, the Penn loam, the least shaly parts of the Penn shale loam, and the "copperstone phase" of the Porters clay show greatest evidence of prosperity. The farm crops common to this section of the country are grown. Some specialization has been made in the growing of potatoes and fruits. A systematic crop rotation is generaly practiced.

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The total area surveyed in Pennsylvania, including areas previously reported, amounts to 1,978 square miles.

RHODE ISLAND.

A survey of the entire State was in progress at the beginning of the fiscal year, and has now been completed. The land surface comprises an area of 1,085 square miles. It is generally of a hilly character, which becomes more mountainous in the western interior. Eleven types of soil were recognized and mapped. Of these, the Gloucester stony loam covers 46 per cent of the State. The most important general farm crop is hay, with corn, potatoes, and oats in the order named. The growing of sweet corn and vegetables and the market-garden industry are important and promise still further development upon the soils adapted to such purposes. The amount of poultry raised is exceptionally large.

SOUTH CAROLINA.

Besides the survey of Lancaster County, 375 square miles of York County were completed during the past fiscal year.

Lancaster County has an area of 436 square miles, of which the greater portion lies in the Piedmont Plateau. The southeastern section extends into the Coastal Plain. Six types of soil, exclusive of Meadow, were mapped, 5 of which belong to the Cecil series. In the southeastern part large areas of Norfolk sand exist. This type is especially adapted to truck farming.

The interest of the farmers is absorbed largely in the growing of cotton, but corn, oats, wheat, cowpeas, and truck are also cultivated. The more sandy soils are better adapted to fruit and truck crops than to general farming.

Including the above areas and the areas previously surveyed, 4,002 square miles have been completed by the soil survey in this State.

TENNESSEE.

A survey of Lawrence County was completed in this State and the survey of Henderson County is in progress and will be finished by September, 1905.

Lawrence County (618 square miles) is situated along the Tennessee-Alabama State line, near the northwestern corner of Alabama. The surface varies from nearly level to rolling and hilly. No great variety of soils was encountered, and only 4 types, all belonging to the Clarksville series, were mapped. The Clarksville silt loam and Clarksville clay loam have been found to produce strawberries and cantaloupes of an excellent quality, and the prospects seem bright for the further development of these industries.

The soil survey has covered a total area of 3,046 square miles in this State.

TEXAS.

Four different counties were surveyed in this State during the last fiscal year, and the survey of the fifth (Lee County) is in progress, with approximately 240 square miles completed.

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Anderson County (1,069 square miles) lies in the eastern portion of the State. It contains a great variety of soils. Ten different types belonging to the Norfolk and Orangeburg soil series were found. Upon these the experiments conducted by this Bureau have shown that a high grade of Cuban filler tobacco can be grown. The soils are also adapted to fruit and truck, and these interests are likely to increase.

Houston County (1,200 square miles) joins Anderson County on the southeast. In the northwestern part of the county the soils are very similar to those of Anderson County. In the southeastern part the Lufkin soils predominate. Seventeen different types have been recognized. Large areas of soils of the Orangeburg series are found here, as in Anderson County, and here also the Bureau has demonstrated that tobacco can be successfully grown.

Lavaca County (1,000 square miles) lies southeast of the center of the State. The northern half is rolling, while the southern is flat. Only 3 types were recognized in this survey. Cotton is the principal crop, but corn, tobacco, and truck are also grown.

A survey of approximately 500 square miles was made around Waco, which lies a little east of the center of the State, in the "Black Prairie" belt. The surface is rolling. The soils vary from light sandy loams to heavy clays, giving an opportunity for a diversity of crops. Cotton forms the chief product, while wheat, corn, oats, and hay are grown. The fruit industry is rapidly assuming importance, and there is opportunity for a greater development of both this and the trucking industry.

Including the above areas and those previously reported, 7,479 square miles have been surveyed in Texas.

UTAH.

At the close of the last fiscal year the survey of the Bear River Valley was in progress and 133 square miles had been mapped. The survey was continued during the current fiscal year, a total area of 201 square miles was completed, and 13 types of soil were mapped. A number of these types are similar to those found in the Weber area, which adjoins this on the south. Much alkali was encountered in the western, southern, and southwestern parts of the area and the proper methods of treatment for reclamation are pointed out in this report. The southwestern portion is slightly elevated above the Great Salt Lake, and is used entirely for the production of hay and for grazing. Wheat and alfalfa are the most important crops, but grass, barley, oats, truck, and fruits are also grown in considerable quantities.

Surveys have been made in Utah covering 1,501 square miles.

VIRGINIA.

Soil-survey work was undertaken in three different areas in Virginia during the past fiscal year. The survey of Appomattox County was completed and that of Louisa County is now in progress, approximately 240 square miles having been completed. A survey of an area on York Neck was made, and it is proposed to extend this during 1905.

Appomattox County, containing 340 square miles, is situated in the Piedmont Plateau, not far from the center of the State. The

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soils belong principally to the Cecil series. Corn, wheat, and tobacco have long been the principal crops. Suggestions in regard to improvements in the agricultural methods are given in the report.

Including areas previously surveyed, 4,338 square miles have been mapped in the State.

WEST VIRGINIA.

A survey of Upshur County was begun May 1, 1905. At the close of the fiscal year the work is still in progress and 215 square miles have been surveyed. An area of 39 square miles was previously surveyed in Jefferson County in connection with the Leesburg, Va., area, making the total surveyed in the State 254 square miles.

WISCONSIN.

In this State one survey was completed. The survey of Portage County was begun and will be finished within the calendar year 1905.

The soils of the Superior area, containing 459 square miles, were classified into 8 types, 3 of which are not of any present agricultural value. Of the area, 74 per cent is covered by the Miami sandy loam. The area is almost entirely undeveloped. The adaptation of various crops to the different types of soil found in the Superior area is pointed out in the report for the benefit of new settlers. This adaptation is stated on a basis of general experience in other areas of this latitude where the same soils have been cultivated and their best uses determined.

There have been surveyed in Wisconsin, including areas previously reported, 1,591 square miles.

RECLAMATION OF ALKALI LAND.

During the year the Bureau has continued demonstration experiments in reclaiming alkali lands by underdrainage and flooding in five important irrigated districts of the West. These are situated as follows: The Swan tract, located near Salt Lake City, Utah, in the Salt Lake Valley; the Toft-Hansen tract, south of Fresno, Cal., in the San Joaquin Valley; the Gervais tract, near North Yakima, Wash.; the Cummings tract, a few miles south of Tempe, Ariz., in the Salt River Valley; and the O'Donnell tract, near Billings, Mont., in the Yellowstone Valley.

This work is the direct outcome of the soil-survey work of 1899, when the Bureau began a systematic classification of the soils in the Western States. Considerable attention was paid in this year to the study of the rise and accumulation of alkali and of the most practicable methods to check and prevent the damage to agricultural lands arising from this cause. As area after area was studied it was found that from 10 to 15 per cent of the land in most districts was practically useless for farming unless measures were taken to counteract the evil. In the reports giving the results of the soil surveys it was emphasized that underdrainage and flooding offered one of the most efficient methods for permanently freeing the soil from the injurious salts, or alkali. As time elapsed and no efforts had been made to undertake the reclamation of alkali lands, while the trouble

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increased instead of diminished, the Bureau decided to establish a certain number of demonstration experiments to prove the force of its recommendations. In the report for 1904 the progress of this work was described, showing from the very outset the wisdom of establishing these reclamation experiments. The farmers in each district have watched with the greatest interest the course of the experiments, and while at first, in many instances, altogether skeptical of the methods employed to reclaim the land, as the experiment progressed they have become fully convinced of the value of the work and are planning similar work on their own lands damaged by alkali.

In the Salt Lake Valley, on the Swan tract, the work has been carried on in cooperation with the Utah Experiment Station, which has charge of all seeding experiments. The drainage system was installed in the summer of 1902, but flooding was not commenced until 1903. The 40-acre tract was continuously flooded for several months, and in October, 1903, careful estimates showed that 82 per cent of the alkali had been removed from the soil to a depth of 4 feet. The quantity of salts carried away in the drainage water was estimated at more than 4,400 tons. In the spring of 1904 it was believed the soil was sufficiently free from alkali to grow any shallow-rooted crop. Accordingly a field test was made, which for various reasons, mostly outside of the Bureau's control, was not altogether successful. On those portions of the tract that made a poor showing flooding was resumed the middle of July, 1904, and continued until September 1. At that time the Utah Experiment Station planted 10 of the 40 acres in the tract to winter wheat. In the spring of 1905 the remaining 30 acres were prepared and 20 acres seeded to alfalfa, while other small plats were planted to potatoes, hemp, beans, corn, rape, barley, beets, and oats. Of these crops, the young alfalfa plant is probably the most sensitive to alkali. While alfalfa, after it has once become well established, can withstand considerable alkali, in its younger stages it is easily injured by alkali as well as by unfavorable weather conditions. By July 1 about 10 acres promised to make a satisfactory stand. On the other 10 acres the growth, while scattering and uneven, possessed a good healthy color and has so far not suffered from alkali. Of the other crops planted the hemp has done very well, while the oats, barley, and beets have made a fair growth. It is believed that with an earlier and heavier seeding the alfalfa would have made a very satisfactory growth on the entire plat of 20 acres.

The condition of the soil of the Swan tract has materially changed since the installation of the drainage system. The soil appears much lighter in texture and works up into better tilth. In a few places where the soil was not leached as thoroughly as in the rest of the tract there is still a tendency for the alkali to form a slight crust on the surface, but such spots are small, and there seems no reason why any crop suited to the climate can not be grown on the greater part of the tract if a sufficient quantity of seed be sown at the proper time. Considering the excessive amounts of alkali originally contained in the soil, amounting to 5 per cent in places to a depth of 4 feet, and the fact that an alkali survey made in June, 1905, showed fully 30 acres to contain less than two-tenths of 1 per cent to a depth of 4 feet, the very great improvement in the soil since reclamation operations began will be fully appreciated. The greatest part of this

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improvement was made during a single season's flooding in 1903, for since that time continuous flooding has been carried on only during the latter part of July and August, 1904.

Perhaps in no other irrigated district in the West would an experiment of this nature, when completed, have such far-reaching effects. In the Salt Lake Valley there are thousands and thousands of acres of land lying idle, unfit for cultivation on account of excessive amounts of alkali. By far the greater part of this land contains very much less alkali than the Swan tract originally carried. Most of this immense body of land is quite level, and with the many sloughs and waterways that radiate through it a ready outlet for drainage water can easily be found. With the ready market for all classes of farm produce offered by Salt Lake City and the constantly growing mining camps of the State, it is at once seen what a fine opening there is for capitalists to engage in the reclamation of these large tracts of alkali land. In many places so favorable are the conditions that a single season's flooding will suffice to sweeten the soil to such an extent that a substantial return can be gotten to offset the expenses incidental to draining and flooding the land. As it is, a number of farmers will undertake the reclamation of small pieces of land during the summer of 1905 by the methods which have been so successfully used by the Bureau.

On the Toft-Hansen tract, a few miles south of Fresno, Cal., the progress of the reclamation of a 20-acre piece of land has been very gratifying. On this demonstration tract the Bureau undertook to reclaim land damaged by excessive amounts of black alkali. During the summer of 1904 and the spring months of 1905 enough crops were harvested to practically pay for the cost of installing the drainage system, while a satisfactory stand of alfalfa now covers the greater part of the 20 acres. The indications are now that the land is restored to its former fertility, with no danger of alkali again rendering it practically worthless from an agricultural standpoint.

The land selected by the Bureau was once considered one of the choice farming districts south of Fresno and sold for upward of $200 an acre. By the rise of seepage water and accumulation of black alkali the land became damaged to such an extent that it supported only a rank growth of the resistant Bermuda grass, while scattered pear trees of stunted growth remained as vestiges of former cultivation. The land had greatly depreciated in value and was considered unfit for cultivation at the time the Bureau began operations. The first great annoyance was caused by the tiles filling with the sandy subsoil, which acts like quicksand, but after the first season no serious trouble resulted from this cause, and during the spring of 1905 the drainage system was working more satisfactorily than at any time since it was installed.

As the water supply runs short during August, it was found necessary to cultivate the land continuously to prevent the alkali from rising from the deep subsoil while the extreme hot weather prevailed. By the late fall of 1904 the soil appeared in excellent condition, and had lost the characteristics so common to soils carrying excessive amounts of black alkali. All of the tract possessed the mellow loamy character of the alkali-free soils of the locality, and appeared ready for any crops commonly grown in the valley. At present the growth

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of alfalfa indicates the complete reclamation of the land, and there is every reason to believe, if it is properly managed, no further trouble will be experienced. Many landowners near Fresno have signified their intention of undertaking similar work, and the coming year will undoubtedly see the work well established. With the farmers undertaking the reclamation of alkali lands by the methods advocated by the Bureau the work of the Bureau at this station will cease.

In 1903 a demonstration tract was selected 3 miles south of North Yakima, Wash. The land was unfit for farming purposes and covered with salt grass and greasewood. Examination showed the soil strongly impregnated with black alkali and other salts. A drainage system was installed in the summer of 1903, and flooding was carried on for several months. Flooding was again continued during the summer of 1904. As the surface has considerable fall from north to south and the soil is a fine sandy loam, consisting largely of volcanic ash, great difficulty has been experienced in holding water on the land. Large dikes were thrown up with scrapers, but when the water had been turned into the checks the least pressure seemed enough to break the dikes, or levees. For this reason, and on account of the great capillary power of the soil, which is apparently able to lift rapidly the alkali from the deep subsoil, the complete reclamation of the tract has not been as rapid as hoped for. Again, the supply of water for flooding was not so plentiful during the past year as in 1903. In the fall of 1904 the land was carefully prepared and seeded to wheat. The early growth of this wheat promised very well, but on those checks where there had been the most trouble in holding the water on the land the crop did not come up to expectations.

On those checks where flooding had been more successfully carried on the growth of wheat has been very encouraging. The yield will be large, while the growth of straw is almost phenomenal, in some places being nearly 6 feet in height. Since the condition of wheat on some checks plainly indicates that there is still some alkali present, the entire tract will be flooded, after the wheat is harvested, until late in the fall. Since there will be less difficulty with the levees breaking in 1905 than during the previous year, it is believed that practically all of the alkali can be leached out of the soil by the close of the year. There is no doubt of the wonderful fertility of this soil as soon as freed from alkali, and when fully reclaimed it should compare in value with the better class of fruit and alfalfa land in the neighborhood, which sells for several hundred dollars an acre.

As good farming lands of the district are limited and there are large areas of land damaged by seepage and alkali, the importance of such reclamation work is apparent. From statements made by several farmers it seems evident that as soon as the reclamation of the tract selected by the Bureau is completed they will engage in similar work.

The Cummings tract, situated south of Tempe, Ariz., during the past year has shown great improvement. The drainage system on this tract was installed early in 1904, but for several months the water supply was so low that the entire valley suffered. During this time flooding could only be practiced at long intervals, so that little permanent good was accomplished. In August, 1904, heavy rains fell, and these have continued at intervals during the past winter

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and spring. With a more abundant supply of water the tract was thoroughly flooded, and on much of the tract tests with grain crops have indicated that the land is in excellent condition. The work of the Bureau has shown what can be accomplished within a few months with an abundant supply of water for flooding.

Only one of the lines of tile in the Cummings tract has discharged water, the greater part of the drainage having passed downward into the deep subsoil. The water table for the past year has been many feet from the surface, but within the last few years stood near the surface and at one time covered the surface of a part of the tract. The present low condition of the water table is due to a number of years of light rainfall. During the winter of 1904 the water table rose rapidly, but did not reach the level of the tile. If the ground water permanently remain many feet from the surface, it would seem that the installation of a drainage system was unnecessary to reclaim lands in the valley; but of this there is no assurance, since a few years of heavy rainfall would soon raise the water table to its former height. With a sufficient water supply for flooding, the entire tract should be entirely reclaimed by January 1, 1906, as the soil readily permits water to leach through it, thereby rapidly removing the alkali in solution. The success attained up to the present time shows that the reclamation of alkali lands in this locality can be accomplished in a comparatively short time, and farmers owning such lands in the valley can well afford to turn their attention to such work.

The O'Donnell tract in the Yellowstone Valley, near Billings, Mont., was the last experiment to be taken up by the Bureau. Preliminary arrangements were made during the latter part of the preceding fiscal year, but the actual installation was not completed until November, 1904. The tract selected consisted of 20 acres belonging to Mr. Ed. O'Donnell, situated about 1 mile west of Billings. The soil is locally known as gumbo, and is characteristic of large areas in the Yellowstone Valley. It is strongly impregnated with sodium sulphate, a form of alkali not especially injurious unless contained in the soil in excessive amounts. The soils of the valley are largely derived from the breaking down of the Fort Benton shales, and it is from these shales the accumulated alkali is derived. The rise of alkali is comparatively recent in the valley, as it is only during the last ten or twelve years that lands have become damaged. At present, however, the damage from alkali and seepage water is very serious and rapidly increasing. This has been shown by the Bureau's studies first made in 1897 and 1898, and later by a soil survey made in 1902, showing the exact amount of land injured by these causes. Seepage from the canals on the higher bench lands has caused large areas to become waterlogged, while the area of alkali land rapidly increases from year to year. Owing to the completion of a large high-line canal during the last year the damage from these causes will undoubtedly increase even more rapidly than before unless extreme measures are at once undertaken by the parties most interested. As the Reclamation Service of the U. S. Geological Survey will in the near future open to settlement nearly 200,000 acres of land near Billings, it is evident that the installation of a demonstration tract in this locality was especially fortunate, since some of the lands soon to

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be irrigated will probably suffer from alkali and seepage after irrigation is practiced a few years.

As Billings is situated a long distance from the nearest tile factory and freight rates are high, it was considered advisable to award the contract for tile to the local brickmakers, who promised to deliver tile by August 1, 1904. They procured a small tile machine and commenced making tile of fair quality. After making a few hundred feet the machine was broken beyond repair and the company decided not, for the present, to procure other tile machinery. As the ditches were by that time partly excavated it was necessary to purchase tile elsewhere. Accordingly, arrangements were made to buy tile from a Kansas City firm, its bid for tile delivered at Billings being the lowest secured. This greatly delayed the installation of the drainage system, so that it was not until November, 1904, that the tiles were in place and the levees thrown up. By that time no water could be had for flooding and no further work could be done. During the spring of 1905 the rainfall was far in excess of any known records in the valley, and this materially aided the reclamation of the soil. The rains were so frequent and heavy that the soil did not dry sufficiently to allow the complete leveling of the land preparatory to flooding. But with the copious rainfall the land has been improved, for the drainage system has worked perfectly, and during the month of June the tiles have discharged large quantities of strongly impregnated alkali water. It is believed that, with the excellent drainage system, continuous flooding for one year will accomplish much toward the reclamation of the tract. The soil is perhaps the heaviest in texture of any of the tracts of land selected by the Bureau, and just how soon the alkali can be leached from it can be determined only by actual experiment.

In this connection it seems proper to mention the results of an attempt at reclamation by the methods employed by the Bureau in southeastern California. Near Mecca, in the Salton Basin, Mr. F. D. Baxter installed a complete drainage system on a small tract of land in November, 1904, and at once began flooding. So rapid has been the progress of the reclamation that early in the spring of 1905 the entire field produced a fine crop of cantaloupes, although the soil a few months ago contained so much alkali that no cultivated crop could be grown. This remarkable success has been achieved in spite of the fact that for a part of the time the tile drains were clogged with silt and the drainage system rendered ineffective. At Mr. Baxter's request the Bureau sent one of its men to assist in freeing the tiles from silt, and it is believed that in the future much less trouble will be experienced from this cause.

In addition to the work carried on at the five regular stations now established by the Bureau, many urgent requests have been made to conduct similar experiments in other localities. The principal places making such requests are Albuquerque, N. Mex., in the Rio Grande Valley; southern California, near Los Angeles; the lower Arkansas Valley, in eastern Colorado; the Payette Valley, in western Idaho; the Bitter Root Valley, in western Montana; and the North Platte Valley, in western Nebraska. While at present the funds allotted to this branch of the Bureau's work will not allow any further extension of the work, it may be possible in the future to conduct reclamation experiments in some of the localities above mentioned. The present

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policy of the Bureau is to complete the reclamation of the stations already selected, and at Salt Lake City and Fresno, where the most progress has been made, to interest the people in taking up the work for themselves. In this way it is believed the greatest good will result from the work.

As the work becomes better established it seems evident from the interest already aroused that the farmers generally will engage in this method of reclaiming their alkali lands. From the experience now gained the Bureau is in a position to give the most complete advice and suggestions to farmers wishing to know what treatment will prove most effective on lands damaged by alkali.

LABORATORY OF SOIL CHEMISTRY.

This Bureau has in the past taken the position that the minerals composing the soil are slowly but completely soluble in water, thus constantly furnishing a supply of nutrient material for plant use. That this supply will be continually kept up has been questioned by some investigators, but during the past year the laboratory has completed an investigation showing conclusively that the position which the Bureau has taken is correct. Work has also been done showing that through capillarity and solution phenomena, dissolved mineral matter is generally being brought into the upper soil layers and held there by absorption. Thus there is a continuous supply of mineral nutrients within reach of plant roots, which is furnished faster than the drainage and leaching processes can remove it.

The absorption and the conservation of certain fertilizer constituents by soils and their re-solution in the ground water have been studied, and the results have shown the extent of these effects to be larger than has generally been supposed, thus furnishing data of great importance for fertilizer practice. In this connection the relative rates of absorption of the constituents from the soil by young plants have been studied, throwing much light on the soil's capacity to furnish mineral nutrients in accordance with plant needs. It has also been shown that different soil types differ very markedly in their power to absorb various kinds of organic substances, and it appears that, in general, soils with the greatest absorptive powers are the most productive, and that the absorptive powers of the soil can be much modified by different cultural methods and fertilizer practices.

Among the most important of the mineral fertilizers are the phosphates of calcium, and there are perhaps more anomalous results reported from studies upon them than from studies upon any other group of substances. It has been shown during the last year that many of these difficulties are due to the entirely erroneous conceptions of the chemical relationships between these phosphates, as illustrated in the current text-books. The relationships existing between the phosphates of calcium and their solutions have been carefully investigated and determined, and we are now in position intelligently to study the chemical problems involved in the agricultural applications of this interesting and valuable group of commercial fertilizers.

The classical method of attempting to determine the fertilizer requirements of a soil by the analysis of the ash of the crop grown upon it has not generally been justified by the data accumulated by various

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investigators. Some recent work, however, has indicated the possibility that some particular crops may be used in this manner for determining the soil requirements with respect to some one or more of the mineral plant food constituents, and the Bureau is cooperating with the Rhode Island Experiment Station by furnishing needed assistance in an exhaustive investigation along this line, which the station has been conducting for several years.

Former work of the Bureau has led to the conviction that, in general, soils readily furnish, through the soil moisture, a sufficient supply of mineral matters for the nutrient needs of the crop, and that the function of mineral fertilizers must be explained in some other way than by ascribing their effect to the addition of plant food. The determination of the question of just how fertilizers produce their valuable results may possibly lead to a rational system of fertilization, which is perhaps the greatest problem now before the scientific agriculturist. It has been demonstrated that the relative cultural value of soils, as determined by crop experience, is shown by the growth of seedling plants in aqueous extracts of the soils. The determining factor in the crop-producing power of the soils is therefore a substance or substances soluble, to some extent at least, in water. Soil extracts can often be improved as cultural media by the addition of various mineral salts commonly used as fertilizers, but improvements just as great have been obtained by the addition of other substances, some of which, as certain phenols or carbon black, contain absolutely no mineral constituents, and some of which, such as ferric hydrate or aluminum hydrate, are so slightly soluble as completely to defy detection in solution. In some cases improvement from changed cultural methods, as by unusually thorough aeration, is as great as can be obtained by the addition of any fertilizer. It would seem, therefore, that there probably are organic compounds in all soils, themselves inhibitory or toxic to plant growth. These affect the crop-producing power of the soils, and they are changed or removed from solution by the addition of the substances mentioned above. In the field or in pot cultures the solid parts of the soil appear to act in a manner similar to carbon black or ferric hydrate, and remove the toxic substances through their absorptive powers, which vary considerably with different soils, as noted above. Whether added mineral salts are effective through direct action on the toxic substances or indirectly by some physiological action on the plants, making them more resistant, or by the stimulation of bacterial or similar growths which may decompose the toxins, is yet an open question, but there is strong evidence, in some cases at least, in favor of the hypothesis of direct action on the toxic substances.

It has been shown that a distinction should be made between toxic substances excreted by the roots of growing plants and those derived from dead organic matter in the soil. A distinction must also be made between different fertilizers, some affecting mainly the development of the tops of plants, while others affect mainly the development of the roots. The progress of this work is being reported from time to time in appropriate publications, and it is confidently believed that the establishment of the fundamental principles cited above will make possible a rational scheme for fertilizer practices and also widen much the scope of these important artificial aids to modern agriculture.

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It would seem that the time has come when progress can be better made by attacking the problem of the soil in its relation to crop production from the synthetical rather than the analytical point of view, and it is along lines so indicated that much of the work of this Bureau has been directed in recent years. The application of modern chemical views respecting solution phenomena, absorption phenomena, colloids, enzymes, etc., to soil studies has demonstrated their great importance in determining crop production; and no less helpful, perhaps, are our present concepts concerning the biological processes taking place in both the soil and the plant. Until these various classes of phenomena have been more thoroughly and systematically studied no basis for a rational fertilizer practice can be obtained. In the progress of the work along these lines two well-marked fields of activity have been developed. In the first there has grown up in the laboratory a class of investigation in which the training of not only the chemist but of the physiologist and bacteriologist is involved, and no one of these can be left out of consideration if success is to be obtained. The problems encountered are developments of investigations which belong essentially to the field of soil chemistry, but with which the resources of the chemist alone are quite inadequate to cope. This class of investigation is practically a virgin field, of the greatest promise for the advancement of agriculture, which might fittingly be called soil physiology, and which promises speedily to require an equipment and organization for its best development and progress. In the second field the working out of methods has progressed to the point where they can with reasonable certainty and comparative ease be applied to practical tests of the relative crop-producing powers of various soils and their fertilizer requirements. These methods have now become the basis of the principal work of the Division of Soil Management.

SOIL MANAGEMENT.

Although it has long been recognized that the factors determining fertility, or the crop-producing power of soils, may be divided into three classes—physical, chemical, and biological—rarely is it possible by inspection of any particular soil to state into which of these classes the predominating factors may fall, and much less is it possible to assign any definite values to the factors. In those cases where the predominating factors can be shown to be purely physical or chemical their control is generally easy, but more often such factors are involved with biological ones, and their satisfactory investigation, if possible at all, requires the employment of more or less refined laboratory methods and equipment quite unsuited generally to practical work in soil management.

The empirical determination of the manurial requirements of a soil, however, without going into the causes of these requirements, is now a comparatively simple matter, owing to the development of the wire-basket and water-culture methods, which were devised in the laboratories of this Bureau. With the use of the basket-culture method it is now possible to secure definite and reliable measurements of the value of the application to any particular soil of various fertilizers in ordinary use, whether chemical fertilizers, barnyard manure, green manure, lime, etc., and definitely to predicate whether any one or more of these substances would be practi-

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cable and economical to use under field conditions. The conditions essential to the use of the wire-basket method of examination are the taking of a large composite sample of soil representative of the field or area to be studied, the mixing of the sample so that every part will be exactly like every other part, the preparation of the soil and the planting of seed similar in every respect for each treatment, and the growth of the plants under identical conditions as regards soil moisture, temperature, air, and sunlight. The control of the conditions has now been so thoroughly developed that experiments can be repeated on the same soil with identical results, a fact seldom obtainable under field conditions owing to the changes in the soil and variations in the seasons. The time absolutely required for testing the soil by this wire-basket method is about twenty-five days, practically the same time required for the chemical examination of soils with the digestion methods in common use in the past. Field experimentation usually requires about ten years' work before it is considered safe to draw definite conclusions.

During the past season a field party from the Bureau of Soils has been carrying on work at the Ohio Experiment Station, with the result that in less than four months they were able to obtain with the use of the wire-basket method practically the same conclusions in regard to the manurial requirements of the Wayne silt loam as have been arrived at by that station as a result of ten years' extensive experimentation in the field. Another party working in the laboratory at the Rhode Island Experiment Station, at Kingston, arrived at conclusions in three months practically identical with those obtained by the station after upward of ten years' field work. It is certain that by the use of the basket method much of the time required for field experimentation can be saved, since all the preliminary results required in such work could be obtained with as great certainty with the use of the basket method. Tests and demonstrations of this method are at present being carried on, and will be continued during the next fiscal year, at the Arlington Farm and at one or more farms at Darlington, S. C., Lancaster, S. C., Florence, Ala., Asheville, N. C., Woodbine, N. J., and Conshohocken, Pa., two stations to be selected in the State of New York, the experiment station farms at Wooster, Ohio, and Strongville, Ohio, and the experiment station farms of the Rhode Island Experiment Station at Kingston.

A much more important development of this method, however, is in its application to the work of the soil-survey parties of the Bureau, and during the next fiscal year it is expected to examine and determine the cultural and manurial requirements of all the important agricultural soils which the soil-survey parties of the Bureau may encounter. Several of the types which have been located and mapped in the past have been studied, and the results obtained as to their agricultural and manurial requirements have been prepared for publication in circulars supplementary to the survey reports already issued. These results in all cases agree in the main with the experience of the best and most successful farmers of the areas.

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LABORATORY OF SOIL PHYSICS.

The Laboratory of Soil Physics during the year covered by this report has continued the investigation of the movement of water in soils and the development of methods for studying the translocation of water and dissolved salts. The relative importance of diffusion and of transpiration of the gases contained in soils has been investigated in connection with the problem of soil ventilation, and especial attention has been given to the rate of capillary movement of water in different kinds of soils when under a condition approximating drought. Determinations have been made of the amount of water lost by evaporation from below the surface of the soil under various conditions of mulching and packing, and a comparative study has been made of the relative loss of water in the same soil under humid and arid conditions.

As in preceding years, the mechanical analysis of soils has constituted an important part of the routine work of this laboratory. During the past year 1,700 samples of soil have been analyzed, most of these samples having been sent in by the soil-survey parties. We have also assisted other bureaus in this connection, over 100 mechanical analyses having been made for the Bureau of Plant Industry of this Department and the Reclamation Service of the U. S. Geological Survey.

In response to the many requests received for a description of the methods of mechanical analysis, a bulletin on this subject was published during the year. This describes fully the methods employed by the Bureau and contains in addition a description of other methods used in the United States at present.

The scheme for soil classification based upon the mechanical composition of soils, which was prepared in cooperation with the members of the Soil Survey, has been given a thorough test during the year and has proved of substantial value in correlating and systematizing our ideas regarding the classification of soils. In connection with this scheme of classification the field men were requested to send in preliminary samples of the soils regarding the classification of which they desired information. This plan has met with the hearty approval of the field force, 237 preliminary analyses having been made during the year, amounting to something over 15 per cent of the total number analyzed in connection with the field work. A tentative scheme of soil classification, subject to revision as the work progresses, has been published in the "Instructions to field parties of the Bureau of Soils, 1904."

The importance in soil investigation of an accurate and reliable method of measuring changes in the water content of a soil needs no emphasis. During the past year an electrical method for this purpose has been developed, which gives promise of fulfilling these conditions. This method consists in measuring by means of short electric waves the electric index of refraction of moist soils, which varies with the amount of moisture present, but which is not dependent to any sensible degree upon the amount of soluble material dissolved in the moisture, and so avoids the uncertainty of the electrical conductivity method formerly employed, resulting from the translocation of the dissolved salts. The work of the year has shown that the electric-wave method is sufficiently accurate for all moisture determinations

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under field conditions. The work at present is directed toward simplifying the apparatus. The combined use of this method and the electric conductivity method will enable us to determine the translocation of both the water and soluble salts in the soil, which will prove of great advantage in investigations connected with the irrigation and reclamation of alkali lands.

Continuation of the investigation with the artificial root, a simple apparatus devised in this laboratory, has proven it to be an effective means of determining the composition and concentration of the soil solution under actual field conditions, provided the moisture content of the soil is sufficiently high to enable a portion of it to be extracted. A brief description of this apparatus has been published.

Probably no physical characteristic of the soil is of more importance than its relation to water, and a classification of soils upon this basis can not fail to prove a valuable adjunct to other systems of classification. A centrifugal method has been developed by which the water content of a series of soils can be brought into capillary equilibrium, so that no interchange of moisture will take place when the soils are put in contact. This is accomplished by means of a powerful centrifugal machine carrying eight samples of moist soil and running at a definite speed, which reduces the moisture content of each sample until it is in equilibrium with the centrifugal force developed by the machine, and in consequence is in capillary equilibrium with each of the other samples. It remains only to determine the moisture content of each sample when in this condition in order to classify it in its relation to water with the other samples examined. An investigation of this kind of the more important soil types established by the Bureau is now in progress and the results will soon be published.

During the year a study of the diffusion and transpiration of soil gases through various types of dry and moist soils, made with the view of determining the extent and relative importance of these two agencies in soil ventilation, has been completed. The results of the work have been published in Bulletin No. 25 of this Bureau, and show that the rate of diffusion varies approximately as the square of the porosity of the soil and follows the laws of the free diffusion of gases. It thus becomes possible to calculate the rate of ventilation in any particular soil from experiments on free diffusion. It is shown that the aeration of soils is almost entirely due to diffusion phenomena, changes in barometric conditions having very little influence in comparison.

The Laboratory of Soil Physics has been charged with the construction and repair of the apparatus used in the soil survey and alkali reclamation work and has assisted in the designing and construction of apparatus for other lines of work in the Bureau. This work has been greatly aided by the employment of a skillful mechanician. The establishment of a small shop has proved of the greatest assistance, and much mechanical work which had formerly to be done outside is now done more quickly, more economically, and better in this shop.

TOBACCO INVESTIGATION.

During the fiscal year just closed investigations for the improvement of tobacco have been continued in Texas, Alabama, South Carolina, Ohio, Virginia, and Connecticut. The experimental tobacco

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grown and packed during 1903-4 in Texas has been disposed of to the trade, and very favorable reports have been received from those who bought it. The prices obtained for this tobacco ranged from 28 to 40 cents a pound, averaging 30 cents a pound, and were considered so satisfactory that the farmers of eastern Texas decided to engage in the industry, providing the tobacco experts of the Bureau remained in Texas to supervise the work. Headquarters were established at Palestine, Anderson County, with substations at Nacogdoches, in Nacogdoches County, and at Crockett, in Houston County. In all 102½ acres were planted by thirty-four farmers in the three counties.

The product of the entire acreage has been contracted for by a Chicago firm of leaf dealers at 15 cents a pound in the unfermented state. There has thus been created a ready market for the Texas product. The tobacco grown by the Bureau during 1904 and packed during the early part of 1905 is undergoing the process of aging. This tobacco is the property of the Department of Agriculture, and when sufficienty matured will be used by the Department as samples to ascertain with still more certainty the commercial value and desirability of the leaf for cigar purposes.

In Alabama satisfactory crops have also been grown, the experimental crop having been sold for 32 cents a pound. This year (1905) 15 acres are in cultivation under the supervision of the Bureau's experts, who have their headquarters at Marion. The agents of the Bureau visit each farmer every week and instruct and assist him in the culture of the crop.

In Ohio the Bureau has practically finished its individual experiment, the 10-acre crop grown in 1903 having been sold to a cigar manufacturing firm in Cincinnati for 35 cents a pound. The crop of 1904 is still undergoing the process of aging. This year eight farmers in Montgomery County are growing 32 acres under Government supervision, a leaf packer in Germantown, Ohio, having agreed to purchase the tobacco from them at remunerative prices.

The work of introducing the bulk method of fermenting the native Ohio tobaccos has been continued, and during the present packing season 23,169,000 pounds will be fermented according to the Bureau's method. This tobacco consists of 16,189,000 pounds of Zimmer Spanish, 6,860,000 pounds of Ohio seed leaf, and 120,000 pounds of Little Dutch, all of which varieties are used in the manufacture of cigars. This makes the fourth season that this work has been in progress, and practically all of the packers in the cigar-leaf growing districts of Ohio have now abandoned the practice of case fermentation. The substitution of bulk fermentation has been the means not only of saving thousands of dollars formerly lost through black rot and imperfect curing, but it has also added to the profits of the packers through the general improvement in the several grades of these tobaccos as now put upon the market.

In South Carolina the investigations as to the possibility of growing Cuban seed filler tobacco on the Orangeburg soils in Orangeburg County have been continued, 3 acres having been planted at Singleton. The tobacco grown during 1904–5 in this State yielded 600 pounds to the acre. It is now undergoing the process of aging, and until this is completed it will be impossible to determine its quality.

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Up to 1904 the Bureau had devoted itself to the improvement of cigar tobaccos, but in that year the work was extended into the dark-tobacco districts of Virginia, where the low prices and small percentage of the higher grades of the leaf have recently yielded the tobacco growers of that State unsatisfactory returns for their labor. The growers of the open-fire-cured tobacco were considered to be those most needing assistance. The poorer grades of this tobacco are principally used in the manufacture of snuff, while the better grades are used for plug wrappers.

Appomattox County was selected as the most promising field in which to begin this work, it being the section where most of the plug wrappers are grown and also near the Lynchburg market. The Bureau established a 5-acre experimental tract on a soil known as the Cecil clay. This tract was divided into two fields. One field of 3 acres was planted at the usual time and the other of 2 acres later in the season, so as to determine the effect of the time of planting on the growth of the tobacco. Each field was divided into acre plats, each plat being given different fertilizer treatment. To plat No. 1 of the 3-acre field was applied a fertilizer used by the farmers of the locality, which contained 3 per cent of ammonia, 9 per cent of phosphoric acid, and 3 per cent of potash. This was used at the rate of 400 pounds per acre, at a cost of $5 an acre, giving 12 pounds of ammonia, 36 pounds of phosphoric acid, and 12 pounds of potash to the acre. Plat No. 2 was treated with a fertilizer prepared according to a formula devised by the Bureau. It consisted of 500 pounds of ground fish, 10 per cent ammonia; 100 pounds of bone meal, 22 per cent phosphoric acid; 100 pounds of nitrate of soda, 19 per cent ammonia; and 150 pounds of sulphate of potash, 50 per cent potash. The cost of this fertilizer was $16.40 per acre, and it supplied 73½ pounds of ammonia, 57 pounds of phosphoric acid, and 72 pounds of potash to the acre. Plat No. 3 of the same field was fertilized with 1,200 pounds of ground fish, 10 per cent ammonia; 100 pounds bone meal, 22 per cent phosphoric acid; 150 pounds of nitrate of soda, 19 per cent ammonia; and 250 pounds of sulphate of potash, 50 per cent potash. The cost of this fertilizer was $32.26 per acre, and it supplied 152 pounds of ammonia, 70 pounds of phosphoric acid, and 120 pounds of potash to the acre. Plats No. 1 and No. 2 of the 2-acre field were fertilized the same as plats No. 2 and No. 3 of the 3-acre field. The yields of the three plats of the 3-acre field were as follows: Plat No. 1, 673 pounds; plat No. 2, 873 pounds; and plat No. 3, 1,224 pounds.

On April 28 the product of the 3-acre field was placed on the breaks at Lynchburg, Va., for sale at public auction, and the following sums were obtained:

For tobacco from plat No. 1, $5 worth of fertilizer applied	$45.50
For tobacco from plat No. 2, $16 worth of fertilizer applied	81.09
For tobacco from plat No. 3, $32 worth of fertilizer applied	111.29
Total returns from the plats	237.88

The cost of production of the three plats was respectively $40, $60, and $82, thus showing a net profit to the producer of $5, $21, and $29, respectively. Although this experiment is not conclusive the first year's experience clearly shows that by the judicious use of fertilizer and thorough methods of cultivation it is possible for the Virginia farmer to increase his yield and his profits.

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The work of producing under shade in the Connecticut Valley a wrapper leaf having all the qualities demanded by the trade has been continued. Six acres of tobacco have been planted, 4 on the Hartford Tobacco Corporation plantation and 2 on the Indian Head plantation. In connection with this work experiments are being conducted in plant breeding and seed selection in cooperation with the Bureau of Plant Industry. The object of this work is to develop a type of tobacco especially adapted to the soil and climatic conditions of Connecticut. The Bureau of Soils has also continued its investigations of the demands of the market and the practicability of creating a demand for the Connecticut shade-grown tobacco. There have been distributed 180 bales of shade-grown tobacco since the last report on this work. The details of these sales are shown in the following table:

For domestic use.		For export.	
Number of bales.	Price per pound.	Number of bales.	Price per pound.
2	$1.75	5	$0.70
1	1.50	7	.41½
8	1.25	19	.32½
4	1.00	4	.20
13	.90	33	.16½
47	.80		
1	.50	68	
1	.35	[a] 12	.10
21	.22		
2	.20		
100			

[a] Tops.

An examination of the table shows that 100 bales have been sold for domestic use at prices ranging from 20 cents per pound for second-grade leaf to $1.75 for light wrappers. On a basis of the actual weight of the different bales the average price received for this tobacco was 75½ cents a pound. The 68 bales for export were sold at an average price of 27.8 cents, and consisted of a leaf not suited to the home trade. All of this tobacco was shipped to the German market.

During the ensuing fiscal year it is the intention of the Bureau to continue its work connected with the improvement of domestic filler tobaccos, through the introduction of the Cuban seed-leaf industry in the Southern States and Ohio, and through the supervision of bulk fermentation operations where necessary in the latter State.

In Connecticut the experiments in selection will be pressed, with the reasonable expectation that a type of tobacco conforming in all respects to the demands of the cigar manufacturer will ultimately be evolved. In Virginia the work of improving the various types of shipping tobacco will be extended, and it is proposed, in addition to the station at Appomattox, to establish experimental farms in other districts of the State, where air curing and flue curing are practiced. It is also suggested that investigations be made in the tobacco districts of New York, Pennsylvania, Maryland, and Wisconsin, and in the export-tobacco districts of Kentucky and Tennessee, if funds be provided sufficient for the work.

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REPORT OF THE ENTOMOLOGIST.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., August 28, 1905.

SIR: I submit herewith an executive report covering the work of the Bureau of Entomology for the fiscal year ending June 30, 1905, dividing it, in accordance with your instructions, into the following sections:

(1) A brief review of the operations carried on during the fiscal year 1905.

(2) An outline of the plans proposed for the work of the Bureau for the fiscal year 1906 under appropriations made for that year.

(3) Suggestions as to work recommended for the fiscal year ending June 30, 1907, for use in preparing estimates.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

Beginning with July 1, 1904, the entomological service of the Department began its existence as a bureau, having conducted its work previously as an independent division. Its work during the fiscal year which followed may be classified as follows:

Work on the Mexican cotton boll weevil.
Work on the cotton bollworm.
Work on other cotton insects.
Importations of useful insects.
Investigations of insects damaging forests.
Investigations of insects damaging deciduous fruit trees.
Work on insects injurious to vegetable crops.
Field crop insect investigations.
Work on scale insects.
Work on insects injurious to stored products.
Investigations into the life history of the cattle tick.
Experimental work with insecticides.
Investigations of insects in their direct relation to the health of man.
Work in silk culture.
Work in bee culture.
Miscellaneous investigations and other work.

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WORK ON THE MEXICAN COTTON BOLL WEEVIL.

As indicated in the last executive report of the operations of this Bureau, a portion of the special appropriation made by Congress to the amount of $250,000, to enable the Secretary of Agriculture to meet the emergency caused by the ravages of the cotton boll weevil, and which became available on January 15, 1904, was assigned to this office, the remainder of the appropriation being expended under the direction of the Chief of the Bureau of Plant Industry. The work on the weevil was immediately enlarged, and with the opening of spring extended operations were begun, which were carried on through the remainder of the growing season and, in fact, throughout the whole of the following fiscal year. The headquarters of the work in Texas were located at Victoria, and 18 entomologists were employed. Twelve of these were connected directly with the headquarters at Victoria, although working for the most part at different points in Texas; 5 were assigned for especial work in Louisiana, and 1 was stationed at the Agricultural and Mechanical College of Texas.

EXPERIMENTAL FARMS.

During the season the number of experimental farms was increased from seven to fourteen, located in the following counties in Texas: Limestone, Robertson, Navarro, Wharton, Karnes, Bexar, Washington, Travis, Victoria, Williamson, and Anderson. The acreage of these farms ranged from 40 to 125, and in general the work conducted at these points was an enlargement of the previous work of the investigations referred to in the last annual executive report. All the old locations were retained and new ones were selected in localities recently invaded by the boll weevil. These farms were designed to make it possible for the Bureau of Entomology to study carefully the local variations in the weevil damage, and to devise such modifications of the present cultural system of combating the pest as are required by the local conditions. The territory infested by the boll weevil during this season covered approximately 98,000 square miles in Texas and Louisiana. This territory exhibits probably as great a variation in rainfall, effective temperatures, and other particulars as is exhibited by any area of like size in the United States. The adaptability of the weevil to new conditions, evidenced by its perfect acclimatization in this country, is also witnessed in local variations, due to climatic and other conditions. The fourteen farms of the Bureau of Entomology were watched carefully by competent entomologists. The progress of the weevil was noticed, and whatever means seemed to be necessary to avoid impending damage at any time were at once resorted to. In addition to the testing of the general cultural method in various localities where these farms were located, some of the more important minor points to be determined were the benefit of planting select varieties, of fertilization, and of thorough cultivation to accomplish the same result, and at the same time to cover the infested squares with earth.

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LABORATORY WORK.

The laboratory work of the boll-weevil investigation has already resulted in the publication of a reasonably complete account of the more important habits of the pest. Much additional information along this line is desired. Accordingly the laboratory work was continued at Victoria, Tex. Over 220,000 observations and experiments were conducted. About 1,000 of these observations dealt with dissemination, 5,000 with natural control, 60,000 with habits, and 3,000 with the various features of hibernation.

A great deal of work was done at the laboratory with various remedies proposed for the boll weevil, including Paris green, which at one time attracted great attention. Experiments were also performed with the object of discovering feasible means of destroying weevils in cotton seed and other articles. In connection with the laboratory work a careful record is kept of the condition of the weevils on the experimental farms. A system of records has been devised which shows the exact progress of infestation during the season. Consequently the causes that have contributed to the sudden increase at any time can be definitely determined. This work consequently has a direct bearing upon the possibility of reducing the damage of the pest.

Special attention was paid to the possible effect of birds in controlling the boll weevil. The only basis for a sound knowledge of the extent to which birds may be depended upon to control the pest is the collection and examination of stomachs of birds found in cotton fields. Consequently a large number of bird stomachs were collected in the vicinity of Victoria and elsewhere. They have been examined carefully, and the results have appeared in Bulletin No. 51.

In connection with the laboratory work, entomologists were sent to watch the advance of the pest along the northern and eastern portions of its range. This resulted in a great amount of information as to how the pest reaches new regions, and incidentally furnished the basis for the publication of maps regarding the territory infested.

In addition to the work outlined above a considerable amount of correspondence was conducted from the headquarters dealing with advice to cotton planters.

COOPERATION WITH THE LOUISIANA CROP PEST COMMISSION.

During the year an energetic attempt was made by the State of Louisiana, through the crop pest commission, to check the further advance of the boll weevil. This work was of the greatest importance, as the conditions in general along the western border of the State, where the attempt was made, were undoubtedly more favorable for such an experiment than any region in the United States. The cotton fields were small and isolated. The Bureau of Entomology considered the attempt to check the advance of the weevil of the greatest interest, and placed five entomologists at the disposal of the crop pest commission. These entomologists were sent to the headquarters of the investigation in Texas, where they received instructions. They were then stationed at various points in Louisiana, where the progress of the weevil could best be investigated. Although the Louisiana authorities did not succeed in checking the advance of the boll weevil, the results obtained have been of great

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value. Many important features of the dissemination of the pest have become well known, and the knowledge gained will be of direct benefit to other States that may at any time attempt to prevent the invasion of the pest.

It has been known for some time and pointed out in the publications of the Bureau of Entomology that the late summer and autumnal work of the cotton-leaf caterpillar is detrimental to the progress of the boll weevil. The early fall destruction of the leaves, when this is at all complete, exposes the boll weevil to the action of the sun, which is inimical to it and deprives it of its food supply. The extensive defoliation of the cotton crop in September and October, 1904, in Texas is in a measure responsible for the late start of the boll weevils in the summer of 1905. In Louisiana this phase of the cotton question is much more marked than in Texas. The cotton caterpillar is present every season, and planters generally poison against it. If the late poisonings are omitted and the caterpillar is allowed to increase, the dense foliage of the cotton plant, which is so abundant in the moist bottom lands of Louisiana, will be done away with and the autumnal ravages of the weevil decidedly checked. In this fact lies possibly a practical measure of considerable importance.

COOPERATION WITH THE TEXAS AGRICULTURAL AND MECHANICAL COLLEGE.

The cooperation with this institution consisted of the appointment of two entomologists who were stationed at that institution under the direction of Prof. E. D. Sanderson. In view of the large amount of work conducted by the Department with the boll weevil and bollworm, it was decided that this cooperative investigation should deal only with minor cotton insects. The importance of this work is due to the fact that any one of the very numerous at present minor insect enemies of the cotton plant may develop into a pest of great importance. The results of the cooperation with the Texas Agricultural and Mechanical College have been published in a Farmers' Bulletin.

INVESTIGATION OF THE POSSIBILITY OF CONTROLLING THE WEEVIL AT GINS.

It has been evident for some time that gins have been very important factors in disseminating the boll weevil. The facilities at the disposal of the Bureau of Entomology enabled it to investigate this matter very fully. A specially trained ginning expert was employed in connection with this work, and a large number of experiments were performed with gins in actual operation. The ginners of Texas and Louisiana were circularized in connection with this investigation. The work led to the publication of a Farmers' Bulletin at the height of the ginning season in the fall of 1904.

INSPECTION OF FARM PRODUCTS QUARANTINED AGAINST BY STATE LAWS.

During the season of 1904 very great inconvenience was caused in many parts of the South by quarantine laws designed to prevent the dissemination of the boll weevil. In many cases the laws were much more stringent than necessary. At the suggestion of the Bureau of Entomology, in several States the rules and regulations were modified in such a way as to permit the shipment of such commodities as would be certified by the Bureau. This placed a very large amount

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of work upon the force in Texas, but was the means of relieving the situation to a great extent. Under the certification of the Bureau of Entomology about 500 carloads of Texas products, which could not otherwise have reached their natural market, were shipped. In all, 1,305 authorizations were issued during the season. Of this number 1,145 covered shipments to the State of Louisiana, while the remainder were divided principally between the States of Georgia and South Carolina, although a small number were issued for shipments to Mississippi, Alabama, and North Carolina.

In addition to the direct police work in furnishing certificates, the Bureau of Entomology cooperated with the various State authorities in furnishing advice concerning the most effective and simple forms for their regulations. Early in the season there was the greatest confusion on the part of the shippers and transportation companies, due to the diversity of the various State laws and changes made in the regulations based upon them. Through the efforts of the agent in charge of the boll-weevil investigation in Texas, the quarantine officers of the Southern States met at Jackson, Miss., and passed resolutions looking toward a uniform system of quarantine, which has since been put into effect by most of the Southern States.

INVESTIGATIONS IN MEXICO AND CUBA.

From time to time the Southern newspapers contained rumors of the occurrence in Mexico of a species of tree cotton supposed to be immune to the attack of the boll weevil. So much attention has been paid to the rumor that a number of planters have sent to Mexico for seed, and the requests for information from the Bureau of Entomology have been numerous. Accordingly, an agent of the investigation in Texas visited Mexico on two different occasions. He conferred with a number of planters who had experimented with the variety supposed to be immune, and visited many of the experimental tracts. The investigation showed that the rumors of immunity were without basis in fact. The possibility of obtaining effective parasites of the weevil was investigated in connection with the study of the Mexican tree cottons. Experiments in the cultivation of cotton in Cuba were continued during the season. The important feature of the investigation was to reveal the possible factors in controlling the pest in a region where it has existed as an important enemy for a much longer period than in the United States. Upon the suggestion of the Bureau of Entomology, Mr. Edouard Ferrer, of Santa Clara Province, destroyed the wild cotton plants growing on and in the vicinity of his plantation some time before planting took place. He has reported that the experiment was a complete success. He succeeded in producing a full crop by the means outlined above after several successive failures.

PUBLICATIONS.

As a result of the work with the boll weevil during the fiscal year 1905, the following publications were issued by the Bureau of Entomology:

Farmers' Bulletin No. 209, entitled "Controlling the boll weevil in cotton seed and at ginneries."

Farmers' Bulletin No. 211, entitled "The use of Paris green in controlling the boll weevil."

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Farmers' Bulletin No. 223, entitled "Miscellaneous cotton insects in Texas."

Farmers' Bulletin No. 216, entitled "The control of the boll weevil, including results of recent investigations."

Circular No. 56, Bureau of Entomology, entitled "The most important step in the cultural system of controlling the boll weevil."

Bulletin No. 51, Bureau of Entomology, entitled "The Mexican cotton boll weevil."

In addition to the above publications regarding the boll weevil, the Bureau of Entomology cooperated with the Texas and Louisiana sections of the Weather Bureau in the frequent publication of maps, showing the exact distribution of the pest. In this way the Texas section issued maps on July 19, August 23, August 30, and November 1. The Louisiana section issued similar maps as special boll-weevil bulletins Nos. 1 and 2, on September 29 and October 29, respectively.

In addition to the regular publications of the Bureau of Entomology, at its suggestion Dr. R. J. Redding, director of the Georgia Experiment Station, prepared Farmers' Bulletin No. 217, entitled "Essential steps in procuring an early crop of cotton."

WORK ON THE COTTON BOLLWORM.

The work in progress at the close of the fiscal year 1904–5, already reported on, was continued without material change to the close of the growing season of 1904.

In the laboratory at Paris, Tex., the investigation of points in the life and habits of the bollworm was continued, special attention being given to a study of its parasitic and predaceous enemies. Much time also was devoted to a study of the habits of the insect under natural conditions in the field. One man devoted practically all of his time during the months of August and September to the collection of data on the comparative injury by the bollworm to early and late planted cotton, as was to be observed on plantations in many parts of Texas where plantings of this character occurred.

Upon the gathering of the several cotton crops grown under contract it was found that the crop produced on five out of the seven experimental farms was in excess of the amount guaranteed the planter by the Department, thus emphasizing the results secured in 1903 of the value in avoiding bollworm injury of a system of farming calculated to produce a crop of cotton before the period of greatest injury in August.

The experiments with late-planted corn as a trap crop to protect cotton from bollworm injury again showed the value of this procedure. A trip of investigation through the southeastern cotton-belt States was made to determine, if possible, the reasons why that section enjoyed comparative immunity from bollworm injury as compared with the States west of the Mississippi River. The explanation sought, it is believed, is to be found in the practice of crop rotation and crop diversification in vogue in those States, especially the planting of corn after oats or other early maturing crops, or on the lower and hence later situations on the farm. The planting of corn in the ways mentioned is very general, is in effect the execution of the trap-crop idea, and serves to protect cotton from serious injury.

Extensive experiments with poisons were carried out in Texas and

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Louisiana, but owing to the comparative freedom from bollworms of the fields under experiment decided results were not secured.

During the two years that the bollworm investigation has been in progress practically all points of importance in the life, habits, parasites, etc., of the insect have been thoroughly investigated. The results of field experiments have shown the value of the so-called "cultural methods," of the use of corn as a trap crop, and, during periods of severe bollworm injury, of the use of arsenical poisons in bollworm control. With the close of the season of 1904 the investigation was practically concluded, except for the continuance of demonstration work. The laboratory at Paris, Tex., was discontinued with the completion of the work in 1904, and the force engaged in the investigation returned to Washington. The principal results of field experiments in 1904 were submitted January 14 and published in Farmers' Bulletin No. 212, superseding Farmers' Bulletin No. 191, containing results of field work in 1903. The final report on the investigation was submitted February 6 and published as Bulletin No. 50 of this Bureau.

To sum up, it may be said that the investigation has resulted in a very accurate knowledge of all important points in the life history of the bollworm throughout the entire year. The field experiments have furnished ground for the following recommendations for lessening bollworm injury:

(1) Thorough plowing of land in the fall to destroy as many hibernating pupæ as possible.

(2) The use of seed of early fruiting varieties of cotton.

(3) The use of fertilizers to hasten and increase fruit production.

(4) Early planting in the spring.

(5) Early and thorough cultivation.

(6) Crop rotation and diversification, to include the late planting of corn to act as a trap crop in protecting cotton from injury.

(7) The use, during periods of severe bollworm injury, of arsenical poisons.

In view of the satisfactory status of this investigation as just indicated, it was deemed best during the growing season of 1905 to confine all work concerning this insect to field experimentations and demonstrations. In the spring contract and cooperative experimental farms were established in the following localities, which present a wide range of soil conditions: New Boston, Tex., 48 acres, sandy loam; Pope, Tex., 40 acres, Red River bottom; Rosser, Tex., 40 acres, Trinity River bottom; Greenville, Tex., 40 acres, black waxy; Quinlan, Tex., 60 acres, postoak and gray prairie; Mound, La., 55 acres, Mississippi River bottom; Ardmore, Ind. T., 60 acres, mixed loam. On these 343 acres an effort is being made to demonstrate the necessity of securing an early crop and to determine further the value of early maturing varieties, fertilizers, and thorough cultivation in making a crop of cotton before the period of greatest bollworm damage.

The following lines of work were also started and carried on to the close of the fiscal year and on into the current fiscal year:

(1) An endeavor has been made to thoroughly demonstrate the value of the trap-crop system in protecting cotton from bollworm injury by securing the cooperation of numerous farmers in the vicinity of Clarksville, Tex., in the planting of small areas of late corn and cowpeas adjacent to cotton. Less extensive tests of this method of

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control are being carried out in other localities; also tests of other favorite food plants in protecting the cotton crop.

(2) Experiments with arsenical poisons dusted upon the cotton. A considerable acreage is being treated in this way.

(3) Experiments at Quinlan, Tex., and Atoka, Ind. T., to determine the value of locally exterminating the larvæ of the first broods of the insect upon early corn.

(4) Experiments with mechanical devices calculated to remove the larvæ from the cotton plants.

(5) A test of numerous varieties of sweet corn to determine their relative susceptibility to bollworm attack, and to devise means of combating the insect upon this crop.

(6) Determination of the value of fall and winter plowing in destroying the hibernating pupæ.

(7) Special attention is being given to natural enemies and their preservation in the fields.

(8) Minor laboratory experiments are being conducted in Dallas, Tex., during the season.

WORK ON OTHER COTTON INSECTS.

During the larger part of the fiscal year investigations were carried on at the Texas State Agricultural Experiment Station, in cooperation with the entomological department of that station, and full notes were taken and many experiments made with a number of cotton insects of considerable importance, though of lesser destructive powers than the boll weevil and bollworm. Among those studied were the different species of cutworms, the cotton webworm, several species of leaf caterpillars and leaf chafers, certain grasshoppers, several species of plant lice, leaf bugs, and plant bugs, and the true sharpshooter, the work of which during the early appearance of the boll weevil in Texas was confused with the damage done by the more important species. The results of these investigations have been brought together in a bulletin by Prof. E. Dwight Sanderson, who was until the autumn of 1904 the entomologist of the Texas State Agricultural Experiment Station, and have been published in part as Farmers' Bulletin No. 223. The full results may be published at a later date.

In addition to this work in cooperation with the Texas station, an important Mexican cotton pest, known in Mexico as the *conchuela*, a large pentatomid bug (*Pentatoma ligata*), was investigated in the State of Durango, Mexico. This investigation was considered necessary, since there is a possibility that it may become a dangerous enemy to cotton cultivation along the Texas border. A species of red spider injurious to cotton in South Carolina was also studied with some care during the year and the results published as Circular No. 65, Bureau of Entomology.

IMPORTATIONS OF USEFUL INSECTS.

Some space has been devoted in each of the executive reports for the past few years to this general subject, under the heading "Work on insects from abroad," and the efforts which have been made to introduce predaceous or parasitic insects from foreign countries to prey upon and control injurious species in the United States constitute an important part of the work of the Bureau. Aside from the

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additional importations of the kelep or boll-weevil ant from Guatemala, an account of which is given below, the principal work in this direction is an importation of parasites and predaceous enemies of the gypsy moth and brown-tail moth, in cooperation with the State board of agriculture of Massachusetts.

INTRODUCTION OF THE NATURAL ENEMIES OF THE GYPSY MOTH AND BROWN-TAIL MOTH.

So long as the State of Massachusetts with its large appropriations was attempting to exterminate these two insects, and so long as the territory affected by them was so limited in extent, there seemed little to be gained by endeavoring to import their natural enemies; but as soon as the large State appropriations were discontinued this office began on a very small scale, and largely by correspondence, an effort to introduce certain species which might assist in keeping the injurious insects under control. By correspondence with Rev. H. Loomis, of Yokohama, Japan, a number of specimens of a microgaster parasite were brought to this country, but they were all either dead on receipt or their cocoons gave out only secondary parasites. In the same way attempts to introduce parasites from Europe failed, although several such attempts were made.

In the early spring of 1905, however, the State of Massachusetts in making an appropriation of $300,000 to assist infested towns in fighting the gypsy moth and brown-tail moth for three years added an appropriation of $10,000 a year for three years for the purpose of introducing parasites and predatory insects. Congress at its last session also appropriated $2,500 to be expended for the same purpose during the fiscal year 1906. Under these conditions, which provided the necessary funds and made an effort on a large scale practicable, cooperation with the Japanese Government, and especially with the Imperial Agricultural Experiment Station at Nishigahara, Tokyo, and the Imperial Agricultural College at Saporo, was entered into for the purpose of securing expert supervision over the sendings of such Japanese parasites as are known to exist.

In May the Chief of this Bureau visited Boston for conference with Mr. A. H. Kirkland, the newly appointed director of the Massachusetts State work in suppressing the gypsy moth and brown-tail moth, and on June 3 sailed from Boston to Naples. Landing at Naples on June 15, during the remainder of the month he visited Portici, Florence, Milan, and Vienna, securing the cooperation of the official entomologists, Prof. F. Sylvestri, at Portici, and Prof. A. Berlese, at Florence, and collecting specimens for transmission to Boston. He was able, during the latter part of June, to secure the sending over to Massachusetts of many hundreds of parasitized larvæ and pupæ of the gypsy moth, and later from Vienna, from Budapest, Dresden, north Germany, and Switzerland to have many hundreds more transported. At the time of present writing some four hundred puparia of a European tachinid parasite of the gypsy moth are living in confinement near Boston, and may propagate with some degree of success next spring. On the trip the Chief of the Bureau succeeded in enlisting the active cooperation of many entomologists and engaged the services of a number of expert collectors. The results indicate that it will be a simple matter to import a number of species

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of parasites into Massachusetts, but whether they will establish themselves and increase as they do in Europe is a matter for time to decide.

Arrangements were early made near Boston to care for the importations in the most efficient way under the charge of a thoroughly well-posted and careful man. There will thus be no danger of importing new insect pests, and the chances of the establishment of desirable species seem good.

THE KELEP OR GUATEMALAN ANT ENEMY OF THE BOLL WEEVIL.

The preliminary account of the work with this insect, under Mr. O. F. Cook, Botanist in Charge of Investigations in Tropical Agriculture, Bureau of Plant Industry, was given in the executive report for 1904. Mr. Cook was assigned to the Bureau of Entomology to carry on the work with the kelep until some definite conclusion as to its practicability and usefulness should be established. Under his direction laboratory studies ascertained the domestic behavior of the insects and their food habits and methods of rearing their young, as well as the time required for development from egg to adult under different conditions of temperature and food supply. A report has been completed on the social organization and breeding habits, showing that the insect differs fundamentally in these respects from the true ants. New colonies are not established by solitary queens, but by workers from older communities, which carry eggs, larvæ, and queens with them to the new burrow. The species is thus able to propagate with satisfactory rapidity when the conditions are favorable. Colonies have been found with over twice as many pupæ as workers. Such a colony might subdivide twice in the same month. The colonies in Texas which had been left in the cotton fields failed to survive the winter. Low temperature alone does not seem necessarily to have been the fatal influence, as indicated by cold-storage experiments made in Washington in August, 1904. Mr. Cook thinks that many of them were lost through water standing in their burrows, but all of them were so far below normal numbers that the test could not have been made a fair one.

From November, 1904, until the close of the fiscal year careful studies were made in Guatemala; 150 full-sized colonies were introduced into Texas, and these have been located at several points and in a variety of soils, with special care as to adequate drainage. In Guatemala the insect was found in much drier localities than those visited last year, and, so far as now known, the only field cultures of cotton in the Central American region are those protected by this species. The efficacy of the kelep in excluding the weevils from the cotton field was subjected to comparative tests in eastern Guatemala. A field without the keleps was completely devastated by the weevils, while another a short distance away and in a position still more exposed to the pest was kept clear by the kelep until a good crop of bolls had reached full size.

It is hoped that these later importations of large colonies may, with the knowledge we now possess of the habits of the insect, prove able to withstand the Texas winter; but it should be distinctly borne in mind that the work with this natural enemy of the boll weevil is

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purely in the experimental stage and that the habits of the kelep differ so greatly from those of other known insects that nothing may be predicted with any certainty concerning the economic outcome in Texas.

OLDER IMPORTATIONS.

The Asiatic ladybird (*Chilocorus similis*), enemy of the San Jose scale, is in practically the same status indicated in the annual report of last year. Its range of usefulness seems to be rather limited to the southern half of the territory covered by the San Jose scale. It so closely resembles the native species (*Chilocorus bivulnerus*) that even an expert can not distinguish the adult insects, and it is not improbable that the native species and the imported one may interbreed. The imported species is the much more prolific, having four or five broods annually, as against one or two for the native species. The latter is also beginning to accustom itself to the San Jose scale, although very often where the presence of the native species is noted in orchards it is found that it is being attracted by native scale insects also present rather than by the San Jose scale. The imported species has been so widely distributed that it will probably maintain itself and become more and more useful every year. As noted last year, the general use of the lime-sulphur-salt wash and other remedies for the San Jose scale, which have proven their efficiency and are so cheap as to be practically universally adopted, take away the possibility of very rapid multiplication and benefit from such predaceous insects as this imported ladybird.

The black scale parasite in California (*Scutellista cyanea*) has during the past year continued its usefulness in the control of this scale on citrus, olive, and other cultures in central and southern California. This parasite is yielding the most notable success of any importation into California subsequent to that of the Vedalia or ladybird enemy of the white scale.

Other importations are in substantially the same condition described in the last executive report.

INVESTIGATIONS OF INSECTS DAMAGING FORESTS.

As shown in the last executive report, the work of this office on insects damaging forests was not only carried on in close cooperation with the Bureau of Forestry, but during that year was assisted by the detail of an assistant and by the payment of traveling and field expenses from the funds of the Bureau of Forestry, the remainder of the field and office forces and the direction of the work being provided by the then Division of Entomology. With the change of the Division of Entomology to the Bureau of Entomology and with the slightly increased appropriation given by Congress the pecuniary assistance of the Bureau of Forestry became no longer necessary, and the expenses of the forest insect service have been entirely paid from the funds of this office. Intimate cooperation with the Bureau of Forestry, however, has been continued.

Extensive field investigations have been conducted according to the plan indicated in the last report, and the winter months were spent in working up the results.

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SPECIAL LINES OF WORK AT THE FIELD STATIONS.

The work at the Black Hills station consisted of an inspection of the 200 experimental trees and a study of the conditions relating to the depredations by the pine-destroying beetle in the reserve.

The work at the Northwestern station was conducted with headquarters at Hoquiam and Pialschie, Wash., and field of operations in Washington, Oregon, and California. The principal projects which claimed special attention were damage to forests of western hemlock and tideland spruce by the hemlock span worm, damage to living hemlock by the hemlock bark maggot, damage to reproduction spruce, fir, and other conifers by bark weevils, damage to red fir by bark-boring and wood-boring insects, special study of forest-tree Buprestidæ. The work on damage to Jeffrey pine in the Santa Barbara Forest Reserve was continued through the summer and fall of 1904, in which Forest Ranger Roger S. Baldwin rendered valuable assistance. Some additional investigations were also made in the Yosemite National Park.

The work at the southern field station, with headquarters at Tryon, N. C., and field of operations in States south of Virginia, Kentucky, and Arkansas, was continued, and the principal projects under investigation were damage to pine forests by the destructive pine-bark beetle, causes of the death of chestnut timber in the southern Appalachian region, damage by wood-boring insects to girdled and felled cypress timber in the Southern States, special study of natural enemies of forest insects. In addition investigations were conducted on the Biltmore estate in July and arrangements were made with the forester of the estate for cooperation in extensive experiments with felled trap trees.

The work at the Kanawha field station was continued with headquarters at Kanawha Station, W. Va., and field of operations in States north of North Carolina, Tennessee, and Arkansas. The principal projects under investigation here were damage to imported mahogany and other imported timber and lumber by introduced and native insects, damage to hickory, forest, and shade trees by the hickory-bark beetle, damage to oak and hemlock tanbark by insects, damage to commercial and stored hard wood and other forest products by powder-post beetle and other insects, and special systematic and economic study of the Scolytidæ.

The principal project at the substation at Penacook, N. H., and Milford, Pa., was additional investigations on the white-pine weevil.

The work at the southwestern field station, with headquarters at Flagstaff, Ariz., and field of operations in the southern Rocky Mountain region, consisted in the special investigation of damage to pine forests by destructive bark beetles of the genus Dendroctonus, cause of the death of pinyon, investigation of pine-cone insects, general study of pine and pinyon insects, general study of the insects of juniper, red fir, spruce, balsam fir, and aspen insects, and special study of forest-tree Cerambycidæ.

The work at the new Rocky Mountain field station, with headquarters at Centerville, Idaho, and field of operations the Rocky Mountain region east of Washington and California, was begun in May, 1905. The principal projects under investigation here are damage to

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pine timber by species of the genus Dendroctonus; damage to reproduction spruce, fir, and other conifers by bark weevils; insect injuries to forest reproduction; special studies of forest tree Cerambycidæ.

EXPLORATIONS AND SPECIAL INVESTIGATIONS.

The extensive explorations of the past years have resulted in such a general knowledge of the prevailing forest conditions in different sections of the country that there is now much less need of this feature of the work, which at first was of such importance.

In July, August, and September, 1904, trips were made by the special agents in charge to the Biltmore estate, North Carolina, to establish cooperative work; to West Virginia, Ohio, Indiana, Missouri, and Illinois, to investigate damage to forest products at sawmills and storehouses; to Louisville, Ky., and Indianapolis, Ind., to investigate insect injuries to imported mahoganies and other rare woods; between August 18 and September 19, at temporary headquarters, Kanawha Station, W. Va., in the study of the special projects there, and in the preparation of manuscript; in May, 1905, a trip to Milford, Pa., to investigate the white-pine weevil and other forest insects, and give practical field demonstrations to the senior class of the Yale Forest School. Arrangements were also made here for certain cooperative work with the Yale Forest School in the study of methods of combating the pine weevil.

The special agent at the southern field station, in addition to his regular duties, made special investigations of the white-pine weevil at Penacook, N. H., October 13–24; and the special agent at the northwestern field station made investigation of damage to pine and spruce at South Bend, Idaho, and inspected the experimental trees in the Black Hills Forest Reserve, S. Dak., in November, 1904.

All of the field force returned to Washington, D. C., between September and December, where their time was occupied working up results until the spring of 1905, when they again took up work at their respective field stations.

SUMMARY OF RESULTS.

With the results of the past year's work, sufficient complete knowledge of the principal species of insects of forest trees and forest products have been acquired to enable this office to readily identify all such species from specimens of the insects or their work received from correspondents or collected in the field. Therefore the first object of this comparatively new work of the Bureau has been attained, which, in consideration of the fact that so little was known regarding the forest insects of the whole country, is a result worthy of special mention. The increased knowledge of the life history, habits, and natural enemies of the principal economic species, which has been one of the features of the past year's work, is another result of much importance, as is also the increased information on methods of controlling the more destructive enemies and preventing losses from their ravages.

Some of the results at the field stations may be mentioned, as follows:

Recommendations for the control of insect ravages in the Black Hills Forest Reserve of South Dakota were prepared for the special

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use of the Bureau of Forestry. These were adopted with prospects of checking the destructive ravages of the bark beetles in the pine timber of the reserve. The experiments with girdled and felled trees in this reserve have been completed and have demonstrated that the destructive Dendroctonus could not be attracted to trap trees, but that its principal ally (and sometimes primary enemy of the trees) could be easily trapped in trees felled at any time between May and September.

At the northwest field station the investigation of damage to living hemlock timber by the hemlock bark maggot was completed and the results published in Circular No. 61, where it is shown that a serious black check defect in the wood of western hemlock is caused by the combined attack of a bark beetle and the maggot of a fly; that the wood of trees so attacked is very undesirable for the manufacture of timber for certain purposes, but that losses can be prevented by avoiding trees with certain external markings on those growing on low lands, and by selecting trees growing at altitudes above 1,800 feet, which were found to be immune.

The cause of damage to Sitka spruce along the coast and Engelmann spruce in western Idaho was found to be two species of bark weevils of the genus Pissodes. The life history and habits of the Sitka spruce species was worked out.

Special progress was made in the economic and systematic study of forest tree Buprestidæ at the field station and at the office in Washington, D. C.

Recommendations for the control of special enemies of the Jeffrey pine in the Santa Barbara Forest Reserve, sugar pine and lodge-pole pine in the Yosemite National Park, and yellow pine in the Yosemite Valley were prepared and submitted to the proper officials and adopted, with prospects of good results.

The investigation of damage to pine and spruce forests by the destructive pine-bark beetle in the Southern States has been sufficient to warrant the publication of results, which are quite important in showing that this dangerous enemy of pine forests is widely distributed through the Gulf and other Southern States, and that there is indication of a serious outbreak which, with proper precaution in felling and barking lightning-struck and infested trees, could be sufficiently controlled to save the more valuable timber.

Much additional data was accumulated relating to the cause of the death of chestnut timber, and quite complete lists of chestnut insects have been collected, with full notes on life histories.

Most encouraging progress has been made in experiments with felled and girdled cypress to determine methods of preventing losses from insect damage. The results so far indicate that trees girdled from April to October are more liable to attack than are those girdled from November to March. A quite complete list of bark and wood infesting insects of the cypress has been made, and much important data on life history, habits, and natural enemies has been determined. Considerable progress has also been made by the agent in charge of the southern field station on the economic and systematic studies of natural enemies of forest insects.

The cooperative experiments with the forester of the Biltmore estate in felling timber at different dates has already yielded some

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important results in showing how certain destructive insects may be thus trapped and destroyed.

The study of insect damage to imported mahogany and other rare woods from tropical countries is about completed, and the results indicate that much loss can be prevented by proper management of timber from the time it is felled until it is manufactured into lumber in this country.

The continued work on hickory insects has yielded additional facts required for the completion of a bulletin on this subject, which is under preparation.

The general results of work on insect injuries to forest products will be found in an article on this subject in the Yearbook of the Department of Agriculture for 1904. This article is based on original observations, regardless of previously published data.

The studies of the white-pine and allied weevils have been sufficiently completed for the preparation of results for publication. These results show that much of the literature on these insects is unreliable, and that with our present knowledge of the life histories and habits much can be done to control their ravages.

Much progress has been made on the economic and systematic study of the scolytid bark and timber beetles of America north of Mexico, and many native, as well as foreign, species have been identified for other entomologists. One important result of a knowledge of this class of insects from other countries was the prevention of the introduction into California of a dangerous enemy of olive trees.

The investigation of damage to pine forests in the southern Rocky Mountain region by destructive bark beetles of the genus Dendroctonus resulted in the determination and separation of five species which are most responsible for the work, and also the determination of the more important facts in their life history, habits, and natural enemies. It was also found that the Oregon Tomicus (*Tomicus oregoni*) is a primary enemy in this region and causes serious damage to the tops of large trees, often resulting in their gradual or sudden death from subsequent attacks by it and the destructive species of Dendroctonus.

INVESTIGATIONS OF INSECTS DAMAGING DECIDUOUS FRUIT TREES.

The importance of the fruit crop of the United States and the great amount of damage done annually by numerous important insects to the trees producing this crop and to the fruit itself has for some time seemed to demand especial efforts toward scientific and most thorough investigation in this direction with a view to the lessening of the damage. Therefore, in the spring of 1905 an expert was assigned to the charge of this work, and he was given the assistance of three trained men.

The headquarters of the investigation is in Washington, where the immediate facilities for life-history studies are obtained in the insectary. Temporary field stations have been established with the consent of and in partial cooperation with the officials of the State agricultural experiment stations in western New York and at Fort Valley, Ga., and field experiment stations are in progress under the same conditions in Maryland.

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For the present, special attention is being given to the study of the insects injurious to the peach, although other deciduous fruit-tree pests are being collected and bred as opportunity offers. At the field stations and at Washington the same plan of investigation is being followed so far as possible. It is hoped in this way to secure information which shall bring out possible differences in life histories and results following treatment of given species due to climatic or other influences. Attention, however, will be given to the injurious species in these respective sections representing the northern, central, and southern portions of the Eastern United States. Studies of the same species according to a uniform plan over such a range of country have heretofore not been attempted.

The increasing difficulty experienced in obtaining from orchardists the use of fruit trees and plants for experimental purposes, and the limitations surrounding experiments under such conditions, have suggested the desirability of the Bureau having an orchard for this work under its own control. To meet this need an orchard covering approximately 10 acres has been planted on the Arlington Farm. The plantings include standard varieties of apple, pear, quince, plum, cherry, grape, dewberry, currant, and miscellaneous nursery stock.

SPECIFIC INVESTIGATIONS.

Special attention is being given to the following lines of work:

PLUM-CURCULIO INVESTIGATIONS.—This includes tests of arsenical sprays, jarring, and observations on the use of summer cultivation in curculio control. The work is being carried out in western New York on plum and apple; in Georgia, on peach and plum. Careful life-history studies of the insect are being conducted at the insectary, and also at the field stations in a more limited way.

PEACH-TREE BORER INVESTIGATIONS.—Work on this insect (*Sanninoidea exitiosa*) the present year has been confined largely to life-history studies as a basis for remedial experiments planned for another season. The investigation has shown that a second borer (*Ægeria pictipes*), with important differences in habits, is very common on peach trees from Georgia to Canada, and it appears likely that this species has been heretofore confused with the *Sanninoidea exitiosa*.

LIME-SULPHUR-SALT WASH INVESTIGATIONS.—The great variation in the formulæ of this wash, now recommended and in use, suggested the need of experiments calculated to standardize this insecticide as used against the San Jose scale. The scheme as carried out compares 22 different formulæ on scale-infested peach, apple, and plum trees. The work is in progress at both of the field stations, and in two localities in Maryland. A chemical study of the several formulæ is planned in cooperation with the Bureau of Chemistry.

MISCELLANEOUS DECIDUOUS FRUIT INSECTS.—Important or little-known pests of fruit trees sent in by correspondents or collected in the course of travel are studied in the insectary as to their life histories, parasites, etc.

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BIOLOGIC COLLECTION OF DECIDUOUS FRUIT-TREE INSECTS.—Special effort is being made to bring together as many deciduous fruit-tree pests, in their various stages and with specimens of their work, as possible. Material not readily preserved is photographed.

WORK ON INSECTS INJURIOUS TO VEGETABLE CROPS.

Work on insects injurious to vegetables and other truck crops has been continued along the same lines as in previous years.

The investigation of the insect enemies to the culture of sugar beets in the West, which has been made a subject of special study in recent years, has been actively continued, and the results will soon be given to the public. A comprehensive work on all of the insect enemies of this important crop is planned for the near future. Accounts of two entirely new beet pests, the sugar-beet crown borer and a species of false-worm, which attacks sugar beet, have been completed and much information has been gained relative to other beet pests.

The insect enemies of cabbage and other cruciferous crop plants, and of cucumber, melon, and other cucurbitaceous crops, have been under special observation. Experimental work was conducted on a species of white fly (*Aleyrodes vaporariorum*), which is quite destructive to cucumber, tomato, and other vegetables grown under glass, as also to many ornamental plants cultivated in greenhouses. The results of special work on this insect has found expression in a circular entitled "The greenhouse white fly," which gives detailed instructions for controlling the pest by fumigation with hydrocyanic-acid gas and by other methods. A hitherto unobserved habit of cucurbit-feeding insects has been ascertained, which it is hoped will have a practical bearing on the control of one or more of these pests. The discovery was made too late for practical tests during the calendar year 1905.

The very considerable injuries which have been accomplished by the melon aphis for many years have brought about the study of this species, especially in its occurrence in the Southern States. Information in regard to it, and in particular as to the best methods of holding it in control, will soon be furnished.

For many years there has been great need of specific information as to the best means of holding in check the imported cabbage worm. This need has been filled by the publication of a comprehensive account of this insect. A circular of information has been published on the "cabbage-snake" scare, due to reports of the alleged venomous nature of a perfectly harmless hair worm (*Mermis albicans*), which has been the cause of great loss to the cabbage industry in the Southern and Western States, where this crop is a staple.

Concise accounts of the corn root-worms, two important enemies of both sweet and field corn, have also been prepared. The very frequent inquiries that have been made, especially during the last three years, in regard to the best methods of controlling the root maggots have made necessary a preliminary circular of instruction on the means of dealing with them. It includes a consideration of the cabbage maggot, onion maggot, and seed-corn maggot. The first two are among the most important truck insects, and the second is

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the most serious enemy of the onion. A more complete consideration of this topic, which will include other root maggots, is under way.

Several species of lepidopterous stalk borers which affect the stems of a variety of vegetables, such as potato, tomato, and corn, and various ornamental plants, have been very prominent as pests for a number of years, and are the subject of special investigation.

The pepper weevil, a new pest in Texas, into which State it has evidently been introduced from Mexico, has been studied, and a report on it is ready for publication.

FIELD CROP INSECT INVESTIGATIONS.

With the beginning of the fiscal year an extended investigation was planned into the very important subject of insects injurious to field crops. An experienced expert was employed and put in charge of the work, with several assistants, and plans were made for a careful and systematic work which it is hoped will solve many long-mooted questions and will ultimately enable the growth of the most important field crops under different conditions with the minimum of damage from insects. The operations carried on during the year may be summarized as follows:

HESSIAN FLY INVESTIGATIONS.

DISTRIBUTION IN SOUTHERN AND WESTERN UNITED STATES.—Before commencing an investigation of the Hessian fly itself it became necessary to determine its actual limits of distribution, especially to the South and West. It has been found to extend southward as far as Newberry, S. C., and to occur in extreme northwestern Tennessee, while we have been unable to find it in Texas or the southern portion of Arkansas, Indian Territory, Oklahoma, and western Kansas. It has not appeared in any experiment plats of wheat about Sault Ste. Marie, Mich. On the other hand, it seems to occur all through the wheat-growing sections of Nebraska and the Dakotas.

WHEAT-SOWING EXPERIMENTS TO DETERMINE THE BEST TIME TO SOW WHEAT IN FALL TO WARD OFF AUTUMN ATTACK.—These experiments are located as follows: Sault Ste. Marie, Bellaire, Clare, Lansing, and Hudson, Mich.; Andover, Rockaway, and New Richmond, Ohio; Richmond, Ind., and Dublin, Va. In each of these experiments wheat was sown last fall every ten days throughout a period rather more than covering the wheat-sowing season.

While the severe drought that prevailed south of the Ohio River seriously interfered with our plans, early and late sowings coming up almost simultaneously, the general result was to show that the fall brood of the fly had emerged and disappeared in northern Michigan by September 1, while in northern Alabama eggs were numerous and observed November 8 by an assistant. This shows a variation of over two months in the appearance and disappearance of the flies in the fall as between the northern and southern borders of the winter-wheat belt. We have found here a certain uniformity of retardation that will certainly prove of much economic importance, the only exception to this uniformity at present apparent being found in central and southern Michigan, where, under lake influences, we have a situ-

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ation to be anticipated farther to the south and bearing out almost exactly the observations of Professor Lochhead made several years ago in Canada.

INVESTIGATIONS OF HESSIAN FLY IN SPRING WHEAT REGIONS.—These have been placed in the hands of an assistant, with headquarters at Tower City, N. Dak. He received a preparatory training for his work by once inspecting the experiment plats located in the several States; by two trips of investigation, one made in the fall of 1904, and including the wheat-growing sections of Indiana, Illinois, Iowa, Minnesota, Nebraska, Kansas, Oklahoma, and Missouri, and the other in the spring of 1905, which included Kentucky, Tennessee, Alabama, Arkansas, Texas, Oklahoma, Kansas, Nebraska, thence to his temporary station at Tower City, N. Dak.

A preliminary examination of wheat fields of southeastern North Dakota, where spring wheat only is sown, in September, 1904, revealed the presence of the Hessian fly in destructive abundance, not only in early sown wheat, but equally so in plants that could not possibly have been above ground earlier than June 20. Some idea of the extent of the ravages of the pest in spring-wheat fields may be afforded by the fact that there have been several lawsuits between farmers and hail insurance companies to settle the question as to whether Hessian fly or hailstorms caused the damage, in some cases the insect having been shown to have nearly ruined the crop.

These investigations were begun May 1 by starting wheat under cover, and in these cages breeding adult Hessian flies from last year's infested stubble. The outcome has been astonishing, for not only have adults continued to appear from this stubble until after July 1, but by this time the first offspring of the earlier appearing females had developed and oviposited. Thus the first cage contained, July 24, two broods, with ample time before harvest to develop at least a partial third brood. So far as possible the breeding-cage results were checked with field observations, but with adults coming from last year's stubble and both early and late sown wheat the confusion becomes interminable, except where both plants and insects have been isolated. The later-appearing females exhibited a decided aversion to ovipositing on plants that had headed out, but literally showered their eggs on younger plants. In this connection it may be stated that "flaxseeds" found at Rochester, Minn., July 5–7, were giving out flies a few days later.

Introduction of parasites.—By keeping the whole wheat-growing area under observation, carefully noting the increase and abundance of grass and grain insects in one section and the decrease on account of excessive parasitism in another, it may be possible to transfer large numbers of beneficial insects from the locality where they have nearly or quite finished their task of suppression to another region where an outbreak is in the developmental stage. During the season two large consignments of Hessian-fly-infested wheat stubble, determined by breeding during the winter months to be strongly parasitized, were transported from North Dakota to western Kentucky and Tennessee, where a serious outbreak of Hessian fly was then in progress. The results have not yet been determined, but the line of experimentation is a worthy one.

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JOINTWORM INVESTIGATIONS.

A series of extended investigations has been begun on jointworms by an assistant whose headquarters are at Richmond, Ind. During 1904 a serious abundance of jointworms was discovered in wheat in West Virginia, Virginia, Ohio, Pennsylvania, and central Michigan, while rye in Ohio and Michigan was also attacked. Another species was found to attack timothy in many places, while other valuable grasses were found to be more or less infested by jointworms. So much work has been done in rearing these insects, so many parasites have been found, and so many new facts have been ascertained in their life histories, in addition to the discovery of a number of new species, that an entire revision of our knowledge of the group is necessary. The occurrence of the wheat-straw worm (one of the jointworms) in the Southern Atlantic States and its study during April indicates that its importance as a pest has been underrated and that it is quite probable that injuries attributed to the Hessian fly may have been really due to this insect.

PRELIMINARY INVESTIGATIONS.

Some investigations have been made on the insects affecting clover and the insects affecting corn, but these are preliminary in character.

WORK ON SCALE INSECTS.

Work on this important group of insect pests has been kept up systematically throughout the year. The most notable scale-insect damage for the year in the United States has been the extraordinary abundance of the common cottony scale of the maple (*Pulvinaria innumerabilis*). This insect has been much in evidence throughout its range, from the Atlantic seaboard to the Rocky Mountains, but has been especially destructive in Illinois and Michigan. It is an insect which it is difficult to control by sprays or direct applications, the best results being gained by winter treatment with an oily wash. It is a native species and is normally controlled by native parasites and predaceous enemies. The maple scale, however, during the last two years has got very much the start of these natural enemies, and a great deal of anxiety has been expressed by park commissions and private individuals throughout the area infested. An investigation of the situation this summer has demonstrated, however, that the natural enemies are very quickly gaining the upper hand of this pest. The most efficient means of control is a native ladybird (*Hyperaspis signata*), which during July has been present on scale-infested trees in enormous numbers, and gives every evidence of quickly bringing this scale pest into control.

The scale insects are among the principal depredators on the cultures in subtropical districts, and an investigation was made particularly of these enemies of subtropical plants in Florida, Cuba, and Porto Rico during the late winter and early spring of this year.

The necessity of a great deal of laboratory work in this group was pointed out in my annual report of last year. This comes from the making of identifications for experiment stations throughout the country for collectors and fruit growers, and the maintenance of as

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large a collection for comparison as it is possible to get. A good deal of experimental work with remedies has been done in connection with the field work in the deciduous fruit section.

WORK ON INSECTS INJURIOUS TO STORED PRODUCTS.

There has been a considerable falling off in the number of complaints which are usually received every year of shortage incurred through the ravages of weevils and other insects to cereals and cereal products and vegetable and other perishable commodities kept in store. It has been learned, however, that the Mediterranean flour moth continues to increase its range, as was noted during the last fiscal year. Its occurrence has recently been reported in new localities in Missouri, Pennsylvania, Kansas, Ohio, Michigan, and Iowa. Where it occurs in flouring mills it is being treated by means of fumigation with both bisulphid of carbon and hydrocyanic acid gas. On account of the inflammability of the former insecticide, the latter form of fumigation is sometimes found desirable as a substitute. A test of the hydrocyanic acid gas method was made for the destruction of flour beetles in flour in a large bakery in the District of Columbia, with very fair success. Advice was given to persons applying for it, in regard to the use of cheap flour bags, which were in somewhat general use for the transportation of flour in railway cars and on shipboard. These bags permit the increase of flour beetles and other insects which a better quality of bag will largely prevent.

Questions of an intricate nature have been asked and answered, which could not be considered in Farmers' Bulletin No. 45 in the space then at command, and an enlarged revision of this publication, which has reached an edition of 270,000 copies, practically all of which have been distributed, will soon be necessary.

There has been considerable demand of late for information in regard to cold storage as a remedy for or preventive of injury by insects affecting stored products. In the case of weevils affecting leguminous seeds, especially cowpeas, this demand has been met by an article by Mr. J. W. T. Duvel, of the Seed Laboratory, Bureau of Plant Industry, which will be shortly published by the Bureau of Entomology. A new weevil enemy of this class of seed crops has recently made its appearance and there is danger of its general introduction into the Southern States.

Experiments were conducted with hydrocyanic acid gas as a means of destroying the cigarette beetle. It was useful in demonstrating that this method of treating the pest can not always be employed with profit, as it is not sufficiently thorough.

INVESTIGATION INTO THE LIFE HISTORY OF THE CATTLE TICK.

At the repeated solicitation of the experiment station authorities in the South and of cattle raisers the Bureau of Entomology has, in cooperation with the Bureau of Animal Industry, undertaken a careful study of the life history of the tick which transmits Texas, or splenetic, fever of cattle. These life-history studies will be conducted in cooperation with experiment station entomologists and others as rapidly as possible over the entire tick area in the Southern States below the quarantine line established by the Bureau of Animal Industry. This work has already been begun in connection with the

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stations of Texas, Louisiana, Mississippi, Alabama, South Carolina, and Tennessee. The results of these studies will be useful in determining the feasibility of the control of the tick by pasturage rotation or by keeping cattle from particular areas for definite periods. The force of trained entomologists which this Bureau has in the South in connection with the boll-weevil work has enabled it to begin this investigation with advantage.

EXPERIMENTAL WORK WITH INSECTICIDES.

A good deal of local work was done in the practical fumigation of houses for various household pests, and of granaries and of food supplies for the destruction of insects depredating on stored food products, to further demonstrate the value of the hydrocyanic-acid gas method of control. The results of these tests were to thoroughly emphasize the very great value of this gas as a means of destroying insects infesting dwelling houses and storehouses.

A rather extensive series of experimental tests of standard and new insecticide substances has also been conducted in the experimental orchard of the Bureau and in private orchards in various important fruit districts in different States. The most important work of this kind has been a series of experiments conducted by the agent in charge of deciduous fruit-tree pests to determine the relative value of the many formulæ which are being used in different parts of the country for the lime-sulphur wash for scale insects. It is the hope, with these tests, to be able to definitely indicate the most economical and serviceable formula for this very useful insecticide.

As a result of the prominence of recent insect damage, as illustrated by the cotton boll weevil in the South, and other important grain and fruit pests, and more particularly as a result of the reward offered by the State of Texas for a remedy for the cotton boll weevil, this office has been flooded with numerous suggestions of remedies for the boll weevil and other insects. All of these have been given attention, and reports have been made to the persons submitting them as to the value, or lack of it, of the substances or remedies suggested. These suggestions have come in great numbers from this country, but also in considerable numbers from foreign countries. Where the insecticides were of uncertain composition and seemed to be worthy of such attention they have been submitted to the Bureau of Chemistry for analysis, and in some cases have been made the subject of field tests. In practically all cases, however, the suggested remedies have been of trivial value, usually of common insecticide substances the use of which was already well known, or unnecessary combinations of these, and very often without any real idea of the practical needs of the problem.

The most promising of the new suggestions for insect control is the use of sulphurous-acid gas (SO_2 and SO_3) for the disinfection of granaries or other storages of grains or seeds, or for the disinfection of dwellings and similar uses. It has already been used to a considerable extent for the disinfection of cargoes of grain on shipboard. Some preliminary examination has been made of the method, and plans are now under way to have it thoroughly tested at the Department, both as to its usefulness for the purposes indicated and also as to the possibility of its use for the disinfection of growing plants, as in the case of greenhouses.

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INVESTIGATIONS OF INSECTS IN THEIR DIRECT RELATION TO THE HEALTH OF MAN.

The investigations indicated in the last report have been carried on during the year, and, with the cooperation of the Carnegie Institution of Washington, an especially careful effort has been made to learn the northward limit of the distribution of the yellow-fever mosquito. This work was practically completed in September, 1904, and is at the date of present writing found to be of great service to the country, since the Public Health and Marine-Hospital Service is basing its recommendations in regard to quarantine measures practically entirely on the results of this work.

Within the limits of the United States the permanent breeding region of the yellow fever mosquito is practically confined to all of the Southern United States which border on the Atlantic Ocean and the Gulf of Mexico, with the exception of those portions of Virginia, North Carolina and South Carolina, Georgia, and Alabama which constitute the foothills of the Appalachian chain; in other words, western Virginia and North Carolina, the extreme northwestern corner of South Carolina, the northern part of Georgia, and the extreme northeastern corner of Alabama. Further than this, the permanent breeding region includes the western half of Tennessee and Kentucky, the extreme southern tip of Illinois, the southeastern corner of Missouri, and all of Arkansas except the northern portion. It also includes portions of the Indian Territory and southern Arizona, and there are points in Utah, Nevada, and California where, if once introduced, the species will undoubtedly thrive with sufficient water supply. In addition to this general region, in the autumn there are extralimital occurrences of this insect which, carried upon boats up the valleys of the Mississippi and Ohio rivers, may at certain points find convenient breeding places and may during the autumn exist for one or more generations. In the same way on the lines of certain railroads there are also extralimital breeding places where in the autumn the insect may exist for a longer or shorter time and breed; thus it was found in the autumn of 1904 breeding at St. Louis, Mo., and it has also been found at Jeffersonville, Ind., on the Ohio River; also at Knoxville and Nashville, Tenn., and at Lexington, Ky. The northern line of permanent distribution, however, coincides fairly accurately with the northern limit of the lower austral life zone as determined by Doctor Merriam, of the Biological Survey of this Department.

WORK IN SILK CULTURE.

The silk work of the Bureau has been carried on in an almost precisely similar method to that indicated in the last report. During the fiscal year 1905, 2,350 letters relating to silk rearing were received. Particular attention was given to the supplying of specific information, and the use of printed circulars as a sole means of supplying information was curtailed so far as possible, the interest aroused by their use being much less than that given by a letter. The correspondence came from nearly all of the United States. New York, Georgia, Illinois, Missouri, Ohio, and Pennsylvania seem to be the points at which the greatest interest centers.

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In the autumn of 1904, 130 ounces of eggs of several different races were secured from Italy, and were subjected to a rigid guaranty of bacteriological examination, indicating absolute freedom from disease. It was found that there was not the marked increase in applications for eggs that had been expected, and investigation showed that fully one-third of the people who had previously engaged in silk culture were now propagating their own supply of eggs. Realizing the danger of the spread of disease germs by means of home-raised eggs by inexperienced people and the discouragement and consequent harm to the industry, attempts have been made to discourage this practice for the present. These efforts were not entirely successful, and very many deteriorated cocoons were offered for sale to the Department. Eggs were sent to 367 persons during the year, and cocoons were received from possibly 130 to whom no eggs had been sent, indicating approximately the number of correspondents who had raised their own eggs.

Sample rearings were made at the Bureau of a dozen or more races of silkworms, the eggs being from the same lots used for distribution purposes. Some races demonstrated a superiority over others, but there was a marked absence of sickness of any kind, although careful microscopic examinations and a strict search for pebrine were made. Two races, the Sferici and Oro, gave admirable results in the vicinity of Washington, the cocoons being seemingly superior to their Italian-raised progenitors. To determine what races are suitable to the United States as a whole is apparently a most difficult undertaking, as the same race raised at sea level and at an altitude gave very different results, and it was found that in one case a great mass of waste results during reeling, while in the other there is a marked absence from waste. This is perhaps due more to humidity than to altitude, and possibly a rainy spell on the high level would have the same effect as normal conditions at sea level.

The effect of cold storage on silkworm eggs has been tested, and it has been found that in a temperature slightly above 32° F. the vitality of the eggs has not been impaired in the least, even though subjected to this temperature for a period of eight months. It was feared that the slight leakage of ammonia gas, which nearly always comes from pipes in cold storage plants, might injure the eggs, but if ammonia was present and in contact with the eggs, it apparently had no effect.

Eggs were distributed to nearly all of the States of the Union, the larger quantities going to California, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and South Carolina.

Mulberry stock was also distributed. In 1904, cuttings of white mulberry were sent out as well as a certain quantity of seed. It was found during that year that the people had great difficulty in raising cuttings and in some instances were unable to show a single surviving specimen by the end of June. Even at the Department of Agriculture, at Washington, under expert management, not more than 25 per cent of the cuttings took root and flourished. It was determined, therefore, to distribute rooted seedlings in the place of cuttings, with the idea that grafting is not difficult and in time can readily be taught by means of literature distributed widely through silk-raising sections. Therefore, the distribution of 1905 consisted almost entirely of rooted seedlings of the best white mulberry, and nearly

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50,000 of these were sent out. Excellent results were gained, and nearly all sent out were planted and are alive to-day. The vitality of these seedlings was well illustrated in a package of 25 which was sent to Colorado, failed to find the addressee, and after some weeks' delay was returned to Washington with the moss packing perfectly dry. The postal authorities had the package five weeks, and yet, after thoroughly wetting the seedlings and planting them, 20 out of 25 took root and are now thriving.

The seedlings thus distributed were raised from 4 kilograms of mulberry seed planted at the Arlington farm in the spring of 1904. A new lot of seed has been planted to be used in the distributions of the fall of 1905 and the spring of 1906. The present mulberry orchard consists of about 150 trees planted several years ago, and several acres have, during the year, been planted in standard varieties of mulberry.

American-raised cocoons were purchased during the year, when they were offered at the rate of from 75 cents to $1 per pound, dried weight. The quality was variable, but some lots of cocoons from persons of two and three years' experience have been exceptionally fine, comparing well with the best quality of cocoons raised in foreign silk-producing countries. In all, 630 pounds of dried cocoons were purchased, and these came from 28 States and Territories.

The reeling operations were commenced in August, 1904, and continued without interruption until the middle of November, when, the ground on which the building stood being required for part of the site for the new Department of Agriculture building, the reeling machinery was moved to other quarters, and the 1st of March the reel was started for the purpose of exhibition to the hosts of visitors to the inauguration ceremonies and was continued at intervals until the end of the fiscal year. An average of 1 pound of silk to 4 pounds of cocoons has been gained with the Department reel, which has also made a record of 1 pound of silk to 3 pounds of dried cocoons. The somewhat low grade of the average American cocoons does not allow the full capacity of the reelers and machine to show except on occasions, but the work turned out, on examination by experts, has proved to compare favorably with the work of foreign silk-producing countries, and the operators are all American girls with one, two, or three years' experience.

The establishment of a large colony of Italians at Milmay, N. J., marks perhaps a first step toward permanent silk culture within that State, already noted for its silk mills, which are now being supplied with raw material by foreign markets. South Carolina has also established an Italian silk-raising colony at Ladsons, which it is understood will carry on truck farming until the mulberry trees shall have attained sufficient growth for use, and will then carry on silk culture in connection with diversified farming. It is understood that mulberry in this locality is planted as a hedge in order that the ground may be unencumbered for other purposes.

The establishment of these two colonies is not the only encouraging feature of the silk-raising prospects at the present time. The recent invention of new reeling apparatus in Europe which greatly reduces the cost of production of raw silk is another encouraging fact. The Chief of the Bureau visited Europe in June and observed the operations of this reel, and also the cocoon harvest and the sale of the crop

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in north Italy. Owing to a rather small crop the price was rather higher than normal, reaching 3.68 lire, or 68 cents, per kilogram of 2.205 pounds of green cocoons. The question of compensation of families for the cocoons reared was observed. The best result noted was in the case of one small, hard-working family, consisting of a husband and wife, an imbecile boy, and two little girls. This family brought in 87.40 kilograms, or 192¼ pounds, for which they were paid 321.63 lire, or about $62. The average amount earned per family on the large estate where observations were made was from $25 to $30, a very welcome addition to the income of a hard-working peasant family. An interesting incident in connection with the sale is the giving of a handful of cocoons from each lot to the church. The observer was told that the peasants naturally picked out the worst cocoons and that the church basket was called "the hospital."

As yet the Department has sold no reeled silk, and it has been considered desirable to allow it to accumulate until a substantial amount has been reeled, which will be sold under the competitive bid system.

WORK IN BEE CULTURE.

With the establishment of the Bureau organization at the beginning of the fiscal year the working force in bee culture was increased by the addition of an expert, two special field agents, and a clerk. This addition to the force has made possible the taking up of certain problems which have been advocated for a number of years, but which could not be worked out while we had but one person engaged in this line of investigation.

During the past year about 60 colonies of bees were purchased, to be used for experimental purposes. The largest number were placed in an apiary located beside the Department of Agriculture building, at Washington, and about a dozen were put into an apiary located on the Arlington Experimental Farm, and there was, in addition to these two apiaries under the management of the home office, a small apiary of 12 colonies placed on the grounds of the Plant Introduction Garden, at Chico, Cal.

During the past year seeds of certain plants which are noted for their honey-producing qualities were distributed to almost 500 bee keepers throughout the United States. The object of this distribution was to find out to what extent it would be profitable to introduce these plants to different parts of the country upon a scale sufficiently large to make them of commercial advantage to the bee keeper. Reports from these plants will be sent in in the fall of 1905, and from these reports it will be possible to ascertain the proper course to be pursued in recommendations to bee keepers of the country and in future distributions.

The subject of bee diseases has been investigated to a certain extent, samples of diseased comb have been received from various parts of the United States, and pure cultures made of the bacteria which they were found to contain. The principal advantage so far obtained from this work has consisted in the information given to the persons sending such combs as to the nature of the disease prevalent in their apiaries and information as to the improved methods of treatment.

The work of distributing queen bees of new races has been continued. The principal distributions which have been made are queens

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of the Caucasian variety, since this race has shown itself to be very superior on account of its very gentle disposition. Queens have also been distributed which were derived from other races, notable among these being the crosses obtained by mating Cyprian queens to Carniolan or Caucasian drones. There still remains a great deal to be determined as to the comparative value of different crosses, and it is hoped that the distributions made, together with the work which will be done in the future, will help to solve this very important problem in apiculture.

The work of introducing into the United States the giant bees of India and the Philippines has at last been undertaken, and Mr. Frank Benton, who is in charge of apiculture in this Department, sailed early in June to take up this work, which, of course, will not be completed for some months. The question of introducing this kind of honey bee has been much discussed by the bee keepers of the United States, and the requests which have come to this Department for help in solving this problem have indicated that the successful introduction of this bee will be very acceptable to the vast majority of the bee keepers of the United States. This bee has practically never been kept in hives similar to those used for the ordinary honey bee (*Apis mellifera*), but certain investigations conducted by Mr. Benton before he was connected with the Department of Agriculture indicate the possibility of such domestication, and warrant the work which has just been undertaken relative to their introduction.

The amount of correspondence which has been received relative to apiculture has very greatly increased during the past year, indicating that this industry is becoming more and more popular throughout all parts of the country and showing a very decided growth of this pursuit.

Several State experiment stations have taken up experimental work in apiculture, and have written for information to this office. Assistance has in all cases been given for this work, necessitating, in many cases, the expenditure of a good deal of time in the outlining of work which would be of particular value to the State in which the experiment station is located.

To facilitate the work of the office, and to have on hand information which is repeatedly called for, a catalogue of the officers of the various State, county, and town apicultural societies has been begun, and will be completed very soon. There has also been started a list of various bee keepers, supply dealers, bee-disease inspectors, and queen breeders, since requests for such information are sent to this office repeatedly.

Assistance has also been given to several persons engaged in more strictly scientific work, such as the furnishing of material for cytological preparations, the study of the development of the honey bee, and certain problems connected with the investigation of the subject of variation.

MISCELLANEOUS INVESTIGATIONS AND OTHER WORK.

Several investigations of importance have been carried on which will not fall under any one of the headings so far used, and of these the principal ones may be summarized here.

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An unusual amount of inspection work was undertaken on nursery stock and other plants, and also on seeds, both for export and import, and fumigation was conducted by means of bisulphid of carbon and hydrocyanic-acid gas. The particular insect pests concerned were scale insects and other small insects, such as plant bugs, small wood-boring beetles, and seed-infesting weevils. As an instance of the importance of this work, it should be stated that numbers of insect pests foreign to this country were detected living in or on the material to be introduced. Seed and other stock for export also contained insects which it was undesirable to send abroad and which necessitated a thorough fumigation before shipment. This work has increased enormously during the year, demanding a large share of the attention of one or two assistants and considerable work from others in the identification of species.

An important series of studies and experiments was made upon a species of thrips, heretofore unknown to science, which has been the cause of what is commercially known as "white veins" on shade-grown tobacco. These studies, which were made in portions of Florida, have resulted in the ascertaining of successful methods of fighting the pest.

Some important insect enemies of the sugar cane in Louisiana were investigated during the year. The sugar-cane beetle (*Ligyrus rugiceps*), a most troublesome pest in the southern cane fields, was given especial study and its approximate life history was determined. This work proved to have a distinctly practical bearing on methods of control which will be largely of a cultural nature. Incidentally three related species came under observation—beetles of similar habits. The results of these investigations will soon be made public.

Special studies of the weevils infesting chestnut, chinquapin, pecan, and filberts were carried on, and the results of some of these studies were published in the Yearbook for 1904. Several species of insects injurious to ornamental plants were also the subject of investigation. These include a leaf roller which is quite destructive to cannas in the Gulf region, and a leaf beetle, injurious to pond lilies.

The usual annual investigation of grasshopper conditions in the West was carried out, but during 1904 these insects were found to be much less destructive than usual, allowing their control by ordinary methods.

In the winter and spring an extensive exhibit was arranged for the Lewis and Clark Centennial Exposition at Portland, Oreg. Portions of the exhibit used at the Louisiana Purchase Exposition at St. Louis the previous year were utilized, but new features were added and revised labels, with the latest information, incorporated. An extensive catalogue of the exhibit was published and sent to Portland for distribution.

The correspondence of the Bureau has greatly increased, necessitating an enlargement of the clerical force.

PROPOSED WORK FOR THE FISCAL YEAR 1906.

Work for the fiscal year 1906, which at the date of this writing is already well under way, will consist for the most part in following out the lines of investigation just indicated.

On account of the greatly increased territory infested by the boll weevil, it was found necessary to remove the headquarters of the

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investigation from Victoria, Tex., where they had been located for three years, to a more central position. On account of railroad and other facilities, Dallas was selected in spite of its location near the northern limit of the infested territory. In view of the almost certain continued spread of the pest it will obviate the necessity of another change of headquarters in case the work is continued for some time. The lines of work conducted last year are being continued, with two exceptions. The investigation of the possibility of controlling the weevil at gins was carried to such a point that it may be considered as completed with the publication of Farmers' Bulletin No. 209. The inspection and certification of farm products quarantined against by State laws is being carried on now in a very limited way. Partly as the result of the work of the Bureau and of fuller information regarding the commodities likely to carry the pest, the quarantine regulations of some of the States have been modified. There is now reasonable uniformity in these regulations, and farm products such as were certified by the Bureau during the fiscal year 1905 are now admitted without restriction. The Bureau is cooperating, and expects to continue to cooperate, with the various State experiment stations in efforts to discover possible isolated new localities of the boll weevil at the earliest possible moment. Two of the Texas experimental farms have been discontinued and replaced by others in Louisiana. Sixteen are now in operation, covering 997 acres, and still others are being worked on a cooperative basis with intelligent planters. An especial effort is being made to investigate the possibility of inducing parasites of northern species of weevils related to the boll weevil to attack that insect.

In regard to work with insects from abroad a thoroughly organized effort is being made to continue the introduction of European parasites of the gypsy moth and brown-tail moth. The services of a number of European entomologists have been engaged, and throughout the winter and the early part of next season large numbers of parasitized specimens of both the gypsy moth and brown-tail moth will be received and cared for in Boston. We hope to continue this work for two more years.

New lines of work are planned for the forest-insect investigations, in cooperation with the Forest Service and specialists in other lines of science, such as insect damage to forest reproduction, and relation of climatic, geological, and physical conditions to damage to forests by insects, interrelation of insects and forests fires to damage to forests, and an investigation of the insect enemies of yellow or black locust.

In the main, however, the Bureau will have its hands full in continuing the investigations already under way, the details of which have been given in the preceding pages, and, furthermore, every year it is safe to count upon some peculiar feature of insect damage which can not well be predicted and which often diverts the attention of a number of experts from work already planned.

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SUGGESTIONS AS TO WORK RECOMMENDED FOR THE FISCAL YEAR 1907 FOR USE IN PREPARING ESTIMATES.

The Chief of the Bureau last year urged that Congress be asked to increase the lump sum appropriated for entomological investigations by $15,000. This was not done, and a number of important lines of work are suffering from shortness of funds; in fact, this may be said of almost every one of the principal classes of investigations, with the exception of that which relates to cotton insects, where the especial appropriation by Congress is ample.

The continuation of the boll-weevil work beyond the fiscal year 1906 seems imperative. The pest is undoubtedly acquiring new habits, and the necessity consequently remains for both laboratory and field work. It is also still spreading, and is about to reach regions in the lower Mississippi Valley, where the observations made in Texas indicate that its ravages will be more serious than they have been in that State. The conditions of rainfall and plantation practice in the Mississippi Valley, and in the eastern part of the cotton belt, indicate that the present cultural system will apply by no means as well there as in Texas. Special investigations in that region are therefore urgently required. In view of this situation, and the increased cost of the investigation on account of the greater territory covered, the Bureau could undoubtedly make excellent use during the fiscal year 1907 of an appropriation of about $100,000 for the boll-weevil work alone; this, of course, being aside from the regular salary and lump appropriations made for the other operations of the Bureau.

The total appropriation to the Bureau in the regular appropriation bill was $84,470, of which $16,410 was appropriated for salaries, leaving $68,060 for the general expenses and investigations. It is urged that this amount, $68,060, be increased by the addition of $45,750.

This increase is recommended for the normal increase of work already undertaken and for the inauguration of new work: In the investigations of forest insects; deciduous fruit insects; insects affecting field crops; apicultural investigations; silk culture; cattle tick investigations; mosquitoes and other disease-bearing insects; insects injurious to tobacco, sugar cane, and rice; the investigations of insects affecting tropical fruits, and investigations of insects affecting truck crops.

In regard to salaries, I respectfully urge that two additional clerks of class 1, two additional clerks at $1,000 each, and one additional messenger at $840 be added, and that the position of clerk at $720 be withdrawn; also, that the salary of the chief clerk of the Bureau be raised from $1,800 to $2,000. This man is overworked, and handles the accounts of the Bureau in addition to his other duties. I also respectfully urge that the Chief of the Bureau should receive $3,500 per annum, so as to place him on a par with the chiefs of the Bureaus of Soils, Statistics, and Forestry, and with the Director of the Office of Experiment Stations. This will make an addition to the salaries of $4,970.

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REPORT OF THE CHIEF OF THE DIVISION OF BIOLOGICAL SURVEY.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., August 1, 1905.

SIR: I have the honor to submit herewith a report of the work of the Biological Survey for the fiscal year ending June 30, 1905, with outline of work for 1906, and recommendations for 1907.

Respectfully,

C. HART MERRIAM, *Chief.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

The work of the Biological Survey is prosecuted along the lines laid down by Congress, as follows: (1) Investigations relating to the geographic distribution of animals and plants, including biological surveys and the determination of the life and crop belts, in charge of the Chief; (2) investigations of the economic relations of birds to agriculture, in charge of Prof. F. E. L. Beal; (3) investigations of the economic relations of mammals to agriculture, in charge of Prof. D. E. Lantz; (4) supervision of matters relating to game preservation and protection and the importation of foreign birds and animals, in charge of Dr. T. S. Palmer.

GEOGRAPHIC DISTRIBUTION.

Perhaps no part of the work intrusted to the Biological Survey is of more importance to the practical progressive farmer than the mapping of the natural life zones of the country, closely correlated as they have been found to be with the crop zones. When these are fully laid down for the entire country, as they have been already for portions of it, the farmer will have a ready, practical guide to the crops most likely to be successful in any given locality and will be saved many costly experiments. During the current year considerable progress has been made in studying the birds, mammals, and woody plants of different regions and in collecting data bearing on their geographic distribution. This primary field work by means of which the life zones are located has been carried on in California, Texas, New Mexico, Colorado, and Alaska. The transfer of the data so gathered to maps showing the distribution of each species, and

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finally to maps showing the entire extent of the country included in each life zone, constitutes an important part of office work, and material progress is being made in it.

Field work in Texas, in charge of Vernon Bailey, chief field naturalist, has been completed, and the work is now being continued in New Mexico and Colorado. Investigations during the current year were conducted in the Taos, San Juan, and Gallinas mountains, in northern and northwestern New Mexico, and in the Antonito and Del Norte country in Colorado. A report on the Texas work has just been completed by Mr. Bailey, and is now in the printer's hands. This treats in detail of the life zones of the State and of its mammals and reptiles, with especial reference to their economic relations.

A report is being prepared by H. C. Oberholser on the birds of Texas, which it is hoped will be completed during the coming year, when we shall possess a very complete knowledge of the natural history of this large and important State, so far as connected with the particular field covered by the Survey.

The biological exploration of the Mackenzie basin, including Great Slave Lake and a part of the barren ground near Great Bear Lake, was concluded in the early part of the present fiscal year.

E. A. Preble, the assistant in charge of this work, wintered at Fort Simpson, on the Upper Mackenzie, for the purpose of studying the conditions of an arctic winter and of being on the ground so as to begin investigations in the early spring. Having finished work at Fort Simpson, he descended the Mackenzie in June, visited Fort MacPherson, on the Lower Peel River, making collections here and at other points on his way southward. The results of the work in this far northern region are of great interest and importance, as they bear directly upon the distribution of many northern types of animal life which enter Alaska and our Northern States, and concerning which previous knowledge has been deficient. Mr. Preble is now engaged in mapping the results of his work and in preparing a report.

Explorations were carried on in the northern Rocky Mountains of the Yukon territory in regions adjacent to and faunally related to Alaska. This work was in charge of Wilfred H. Osgood and was necessary to complete work already undertaken in Alaska. By the cooperation of Charles Sheldon, of New York, who generously defrayed expenses, the party was enabled to visit regions hitherto inaccessible. Two trips were made, one into the Ogilvie Range near the Alaska boundary, the other to the region about the head of the Macmillan River, thus touching the main Rocky Mountains at two widely separated points. The lack of information from these regions has been a serious obstacle to a knowledge of the distribution and relationships of the mammals and birds of Alaska. Reports on the results of this work are now being prepared.

ECONOMIC ORNITHOLOGY.

As in previous years the work on the food habits of birds has been carried on simultaneously in the field and laboratory. The study of birds in their relation to agriculture is assuming more and more importance as increased areas are devoted to crop raising, thus changing natural conditions and disturbing the balance of nature. The

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destruction of mammals and birds of prey that live upon noxious rodents, the slaughter of game and other birds whose natural food consists of injurious insects, the extermination of snakes, and the deforestation of extensive tracts all tend to disturb the harmonious adjustment of nature, and result in the unnatural increase of certain insects, such as the cotton boll weevil, to the embarrassment and serious loss of the farmer. The field study of birds, especially of their food habits, and the examination of the contents of their stomachs to ascertain accurately the nature of the services they render are hence of great and growing importance. Comparatively little field work has been undertaken by this section during the year, as the demand for reports upon material already in hand has taxed the efforts of the available assistants. Work upon the stomachs of birds collected in the fruit-growing regions of California has been pushed as rapidly as possible, but owing to their large number much still remains to be done. The collection of bird stomachs from California, in no small part due to active cooperation of fruit growers and ornithologists of the State, is greater than that from any other equal area in the country. This material has involved an unexpected amount of work, but so satisfactory is it that the resulting report will be comprehensive and final. More than 6,000 stomachs from that State have been already examined and several thousand more are awaiting examination.

The legislatures of several States have taken much interest in the food of wild ducks as related to their migrations and to the fixing of a proper open season. In order to furnish information upon this subject, an assistant, W. L. McAtee, has spent several months in studying the food of ducks and geese, of which more than 400 stomachs have been examined. Efforts are being made to procure as many more as possible so that a full report on the food habits of these important birds may be published at an early date.

Investigations of the food habits of the remaining game birds of the United States have been carried on during the year, and were approaching completion when interrupted by the unfortunate illness of Doctor Judd, assistant in charge of the work.

The ravages of the cotton boll weevil in Texas for several years past have been serious, and much thought and attention are being given to methods of combating the pest. In this work it is believed that birds may prove a competent ally, and it is important that a thorough investigation be made of the food habits of the species inhabiting the infested region. This is now being done and will be continued until definite results have been obtained. It has been already ascertained that several species prey upon the boll weevil, and it is important to learn to what extent this insect constitutes an element of their fare. It is believed that other birds that do not now feed upon the weevil will in time learn to do so. The beetle is a recent visitant to the region in question, and birds do not at once acquire a taste for new food or immediately learn the habits of new insects so as to effectively attack them. Hence an insect new to a region may at first enjoy almost complete immunity from the resident birds, and later may become a favorite food of several species.

For some years the food habits of the horned larks have been under investigation. These birds are widely dispersed in the United States, and in some sections have been accused of doing considerable damage

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to grain. A sufficient number of specimens was collected in various parts of the country to permit of a thorough examination, and as a result the horned larks as a group have been ascertained to be decidedly beneficial in most of the country they inhabit, owing to their destruction of noxious insects and weed seeds. In certain sections, however, particularly in California, the bird does damage to seed grain, but this may be easily prevented. A bulletin containing the essential facts of the above investigation has been prepared by W. L. McAtee, and will soon be issued.

A similar investigation is being made of the economic relations of another widely distributed group of birds, the grosbeaks, one or more species of which occur in every part of the United States. Much economic interest attaches to the grosbeaks, as certain of them are reputed to destroy fruit and grain, while two species are known to be good friends of the farmer—the rose-breasted grosbeak showing a decided taste for the Colorado potato beetle, and the black-headed grosbeak of the West feeding largely upon the black olive scale, one of the most destructive insects of the Pacific coast fruit region.

A bulletin on the economic relations of the grosbreaks will probably be ready for publication within the year.

For many years the Biological Survey has received inquiries relative to the trees, shrubs, and other plants that may be cultivated about our homes and orchards for the purpose of furnishing suitable summer and winter food for birds, with a view to increasing their numbers and diverting them from cultivated fruits. It is thought that similar methods may be effective in attracting game birds to depleted preserves. Investigation shows that many plants are suitable for the above purposes, among them not a few that are highly ornamental. It is intended at an early day to issue a bulletin upon this important phase of bird food and protection.

BIRD MIGRATION.

During the year the usual spring and fall migration schedules were sent to and received from the regular observers and filed for future use. In order to round out our knowledge of the migratory movements of our birds special attention has been given to the occurrence of United States birds south of our boundary, and the original records have been searched for such occurrences in the West Indies, Central America, and South America.

Similarly the migration records from Canada have been copied; also the notes received from the Western States (Texas to Montana and westward).

The work in hand at the present time is a bulletin on the "Distribution and migration of North American ducks and geese."

ECONOMIC MAMMALOGY.

A new assistant, Prof. D. E. Lantz, has been put in charge of the investigation of the economic relations of mammals to agriculture. It is well known that in many parts of the country the yearly damage to stock and to crops resulting from the attacks of mammals is great. In many sections the sheep industry is rendered impossible, because unprofitable, owing to depredations of coyotes and the larger wolves,

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while in many others the profits resulting from this industry are much reduced. During the year experiments have been made in Kansas and Oklahoma with a view to testing the practicability of fencing out coyotes from sheep, and of finding a cheap and effective fence. The fencing method, though somewhat expensive in first cost, is believed to promise well, since it is likely not only to completely protect the sheep, but also to improve the pasturage. Moreover, it enables the services of herders to be dispensed with, and hence in the end may prove to be relatively economical. A bulletin on the subject by Professor Lantz has been published; and to give the matter wider currency it has been issued also as a Farmers' Bulletin.

The number of small rodents—rats, mice, and similar mammals—that attack grain, grass, alfalfa, and tubers is surprisingly large, and they exist everywhere throughout the country, occasionally multiplying beyond all bounds. Daily inquiries are received by the Survey asking for instructions as to the best and cheapest method of ridding the farm, the orchard, and the nursery of these pests. As the result of previous investigations more or less practicable methods of controlling the rodents by means of traps, poisons, and other agents have been discovered, and the subject is being further studied with a view to devising still cheaper and more effective methods.

Rabbits have always proved difficult animals for farmers to cope with, and frequently they cause serious damage to nursery stock and other crops. It often happens that after a term of years, during which comparatively little injury is suffered from these animals, their numbers suddenly increase enormously, and the resulting damage is correspondingly great.

Attempts to poison rabbits have sometimes proved highly successful, and renewed experiments are being made to discover a cheap and effective method that may be generally available for the destruction of these pests. In Australia various forms of wire fence have been tried with considerable success, and experiments in this direction will be made in localities in the West where rabbits are most numerous and troublesome.

Prairie dogs and the larger ground squirrels are a perennial source of annoyance in many of the States of the far West, and in places successful agriculture is all but impossible because of their depredations, especially in the Dakotas, Oregon, and Washington. Past experiments have demonstrated that by means of poisoned food and of gases introduced into their burrows the animals may be destroyed. By concerted action on the part of ranch holders there is little doubt that in some sections at least the complete extermination of these mammals might be accomplished. Upon farmers of small means, however, the expense of such work falls heavily and threatens to absorb all possible profits. Renewed study of the problem is now being made by field assistants with the hope of discovering cheaper methods.

GAME PROTECTION.

The conditions relating to game are constantly changing, and the simple and inadequate methods of protection of a few decades ago have been replaced by a complex system of laws requiring for their enforcement the services of special State officials. Every effort has

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been made to secure the adoption of modern methods for the protection of game, to meet the numerous demands for aid and information concerning game laws and methods of enforcement, and to cooperate in every way possible with the several States and the various game-protective associations. The work of the year has been conducted on five distinct lines: (1) Supervision of the importation of foreign birds and mammals; (2) cooperation in restricting interstate shipments of game contrary to law; (3) supervision of bird reservations; (4) protection of game in Alaska; and (5) collection and publication of matter relating to game protection.

IMPORTATION OF FOREIGN MAMMALS AND BIRDS.

During the year 390 permits were issued for the importation of 200 mammals, 250,000 canaries, and 37,000 miscellaneous birds, and 5 for the entry of 2,270 eggs of pheasants, a considerable increase in number as compared with last year.

Practically all of the cage birds and many of the game birds were imported through New York, and 95 consignments, embracing all but a small proportion of the total number, were inspected by the Department inspectors there. Besides these entries there were imported 300 mammals, 3,350 canaries, 12,000 miscellaneous birds, and 200 reptiles (chiefly turtles and snakes) which did not require the issue of permits.

Most of the birds brought in were cage birds, but a large number of game birds were imported for aviaries and a few for stocking covers. These included 1,000 pheasants, 300 quail, 450 partridges, 300 ducks, and 600 miscellaneous game birds. Twenty thousand pigeons and doves were imported, chiefly domesticated species for breeding purposes.

No injurious species have been reported for entry, and, so far as is known, no attempt has been made to introduce any into the country surreptitiously.

CAPERCAILZIE.—The game birds imported include more than 100 capercailzie destined for liberation on Grand Island, Mich. The capercailzie is found in northern Europe, and is the largest member of the grouse family, full-grown males weighing 10 to 12 pounds. The bird is nonmigratory, is extremely hardy, and its flesh is excellent. The results of its introduction into Michigan will be carefully watched. A number brought from Sweden and liberated in Algonquin Park, Ontario, last year, as mentioned in the report of the Biological Survey for 1904, have wintered successfully and appear to be thriving.

PARTRIDGE EGGS.—Investigation of the importation of partridge eggs for stocking purposes, mentioned in the report for 1904, developed the fact that less than 50 per cent hatched. Further inquiry showed the probable cause of this partial failure to be largely injury from the long ocean voyage, and partly the inferior quality of the eggs imported. The second cause particularly attaches to Hungarian partridge eggs, which are said to be carelessly collected by peasants, and subsequently negligently handled by dealers. In the present condition of the trade and facilities for transportation it is doubtful if this method of introducing partridges will justify the expense involved.

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INTERSTATE COMMERCE IN GAME.

The number of cases of illegal shipments of game from one State to another is considerably larger than the previous year. The records of 1904–5 show 23 cases involving the shipment of 1,608 birds and 52 rabbits, as against 10 cases involving the shipment of 700 birds and 36 rabbits in 1903–4. Eleven convictions and several indictments were secured during the year, making a total of 53 convictions in cases passing through the Department since the passage of the Lacey Act in 1900. Of these, 5 were secured in Federal courts and 6 in State courts.

Special mention should be made of the cooperation in this work of the State authorities of Illinois, Iowa, North Carolina, Nebraska, and Minnesota. As in former years, a number of cases in Iowa have been prosecuted in the State courts by the warden, who secured in one instance a fine of $400 on account of the shipment of 248 birds.

FIELD WORK.—Examination was continued of the extent and character of illegal shipments of game and of the methods used by State officials to suppress it in Illinois, Iowa, Missouri, Nebraska, and Wisconsin. Personal inspection was made of the conditions prevailing in these States, and North Carolina also was visited with the same object. Particular attention was given to illegal transportation of game at St. Louis, which, from its geographic position, offers special opportunities for violations of the nonexport laws. Examination of the methods of freight traffic led to the belief that game was carried by hand or by wagon across a certain bridge to East St. Louis and there reshipped. A number of deputy wardens were detailed by the game commissioner of Illinois to watch this bridge, and arrests immediately followed. Eight cases have thus far been presented to the courts, in one of which a penalty of $200 and costs was imposed.

WILD FOWL PROTECTION IN TEXAS.—Wherever possible, organizations and individuals have been aided in attempts to establish or maintain adequate protection of game. Mention may be made of the results attained in Texas, where a strong effort was begun to nullify the law enacted in 1903, prohibiting export of waterfowl from that State. This law was an important step in the preservation of wild ducks, and it is gratifying to be able to report the success of the effort to maintain and enforce it.

THANKSGIVING GAME.—As last year, an investigation was made of the amount of game on the market and the prevalent prices therefor immediately preceding Thanksgiving Day. The detailed results of the investigations of the two years will be published shortly. A growing scarcity of game in the markets is indicated, mainly due to the increase of restrictive laws and more effective enforcement. Venison was entirely absent from the markets west of the Mississippi, and was scarce at several eastern points. Prairie chickens were scarce everywhere, especially in 1904. Quail were scarcer in 1904 than in 1903 in every place except St. Louis, where they glutted the market, probably from an oversupply to meet the demands caused by the Exposition.

With a growing scarcity of native game there is a tendency to supply the market with imported game, mainly different species of

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grouse. Prices for these foreign supplies were not noticeably high, while from 1903 to 1904 the prices of native game showed a tendency to rise.

RESERVATIONS.

PELICAN ISLAND RESERVATION.—As a result of protection afforded the birds on Pelican Island, in Indian River, Florida, the colony is thriving. On November 23, 1904, pelicans were reported by the warden to be more numerous than ever before at that date. The nesting season extended from the middle of November, 1904, to the 1st of May, 1905. The birds returned this season to the main island, arriving in numbers about November 1 and beginning to lay on November 18. Young birds made their appearance a month later and by January 3 were numerous.

BRETON ISLAND RESERVATION.—Three islands, known as Breton, Old Harbor, and Freemason islands, lying off the coast of Louisiana just north of the Delta of the Mississippi River, for years have been frequented by thousands of ducks, gulls, terns, pelicans, man-o'-war birds, and shore birds, the ducks wintering, the others breeding. Owing to plans for the practical extermination of the ducks by market hunters during the winter, an Executive order was issued by the President on October 4, 1904, making the group of islands a bird reservation, to be known as the "Breton Island Reservation," and placing them under the supervision of the Department of Agriculture. A warden was appointed, to be maintained, like the warden of the Pelican Island Reservation, by the cooperation of the Department and the National Association of Audubon Societies, and trespass warnings were posted on the islands. The ducks, which have wintered in their usual immense numbers, have not been molested, so far as is known. The warden reports that mallards, baldpates, pintails, and redheads begin to leave the reservation February 1 and all are gone by February 20, while with black ducks the period of departure is April 10 to 20.

STUMP LAKE RESERVATION.—A third reservation, the Stump Lake Reservation, was created by the President on March 9, 1905. Thousands of ducks and other waterfowl breed on four small islands in Stump Lake, near the center of North Dakota, the total area of which is 27.39 acres. In order to afford adequate protection to the birds during the nesting season an Executive order was issued placing the islands on the same footing as the Pelican Island and Breton Island reservations.

WICHITA GAME REFUGE.—On January 24, 1905, Congress passed an act authorizing the President "to designate such areas in the Wichita Forest Reserve as should, in his opinion, be set aside for the protection of game animals and birds and be recognized as a breeding place therefor," and prohibiting hunting, trapping, killing, or capturing all game animals and birds within such areas, except under such regulations as the Secretary of Agriculture should prescribe. Pursuant to the authority conferred by this act, the President on June 2, 1905, issued a proclamation announcing the establishment of this national game refuge. Upon this tract, which is in the Wichita Mountains, Oklahoma, quail are especially abundant, and the principal value of the measure will probably consist in affording a breeding ground for these birds.

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PROTECTION OF GAME IN ALASKA.

The most important feature of the protection of Alaska game—the regulation of export—has been fully maintained throughout the year, and there appears to have been no resumption of the trade in skins and trophies. The bill introduced into the last Congress, in which radical modifications in the present system were made, failed to become a law. While it was pending, the issue of permits for shipment of trophies was suspended. Hence the number of such permits granted during the year is comparatively small. New regulations were issued in June limiting shipment of trophies to (1) residents of Alaska and (2) persons desiring to export trophies secured prior to 1905. The total number of export permits issued during the year was 10 for specimens, and 12 for trophies. Six shipments reached Seattle without permit. One, consisting of a deer head which arrived in bad condition, was destroyed by direction of the customs officials at Seattle; and two—two caribou heads from Nome and 400 pounds of ivory—owing to special circumstances, were released.

TRANSFER OF ELK.

As stated in the annual report of last year, the preparations for transporting the elk, offered to the Department by Miller and Lux, from Kern County, Cal., to Kaweah Park were completed. Owing to unforeseen difficulties and delays, the attempt to corral the animals was not made till November 12. The animals, however, proved to be so intractable that the effort to drive them into a corral had to be abandoned and several were roped. As a result of their excessive exertion and the rough usage to which they were necessarily subjected only two reached Kaweah Park alive. Owing to this experience another method has been devised, and Miller and Lux have promised to secure a sufficient number of young and yearlings to insure the success of the experiment.

SPECIAL INVESTIGATIONS.

The following subjects have received special consideration during the year, namely: Hunting licenses, migration and protection of shore birds, State organizations for the enforcement of game laws, recommendations of State game officials, and the care of birds in winter.

HUNTING LICENSES.—The widespread interest in hunting licenses and the growing popularity of this method of raising funds for game protection made it desirable to collect statistics regarding their history, objects, and limitations. These were published as Bulletin 19 of this Division. Since the publication of this report five States have established nonresident licenses for the first time, four resident licenses, and four alien licenses.

SHORE BIRDS.—Investigation of the migration of shore birds and the laws protecting them has been continued, and has been extended to include special features connected with the protection of migratory game birds. A report of results will soon be ready for publication.

GAME COMMISSIONS.—Much progress has been made in the work of ascertaining the organization of game commissions and the methods of enforcing game laws. The results will appear shortly as a bulle-

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tin and will include the laws passed in 1905. This bulletin will constitute the third part of the game law series published by the Survey.

WARDENS' RECOMMENDATIONS.—In the belief that the compilation of the recommendations of State officers charged with the enforcement of game laws would be valuable for comparison with bills introduced or passed, and for indicating the general trend of game protection, such a work was completed during the year, appearing as Circular No. 47.

FEEDING BIRDS.—The severe winters of the past two or three years have caused so great mortality among birds that the practice of putting out food for both game and nongame birds has become common. With a view to organizing and systematizing methods, a study of the subject has been made which will be published as a circular.

INFORMATION CONCERNING GAME.

BIBLIOGRAPHY.—The importance of a means of ready reference to game-protection literature has long been apparent, and during the year work was begun on the preparation of a bibliography of the general literature of the subject and of an index of the game laws of the United States from the earliest colonial times to date.

Mention was made in the last report of the need of a bibliography to afford ready reference to the miscellaneous mass of special treatises, discussions, papers, and informal notes, many of which are valuable by way of indicating precedent and procedure. Fair progress has been made in the preparation of this.

INDEX OF GAME LAWS.—This work was undertaken in cooperation with and at the request of the New York State Library at Albany, N. Y., which has in course of preparation a comprehensive index of legislation. Many laws have been carded, and a complete index has been made of those of Florida and West Virginia and of the early laws of New York (covering the period from 1777 to 1820). The numerous local laws of North Carolina, also, for the past twenty years have been indexed.

ROUTINE WORK.

Year by year the routine work of the Survey increases. This consists of correspondence, accounts of expenditures, preparation of reports and bulletins for publication, identifying and labeling specimens, care of collections, cataloguing bird stomachs received, tabulating field reports, sorting and filing published matter valuable for reference, mapping distribution of birds and mammals, attention to the needs of field naturalists, developing photographic negatives and making prints therefrom, compiling game laws, issuing permits for the entry of foreign mammals and birds and for the export of trophies and specimens from Alaska, and cooperation in enforcing the various provisions of the act of Congress of May 25, 1900. The letters received during the year numbered about 6,000. Many of these contained information of value relating to economic subjects, and extracts from them have been filed for future use. The letters written during the same period numbered about 4,500, and 900 migration schedules were sent out to observers.

The collection of negatives made in the field for purposes of study

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and illustration now number about 8,000. They form records of permanent value, which must increase as time goes on.

PUBLICATIONS.

The publications for the year include 1 number of North American Fauna, 3 bulletins, 5 circulars, 2 articles in the Yearbook, 2 Farmers' Bulletins, the report of the Chief for 1904, and 23 reprints of former publications.

North American Fauna, No. 24, by Wilfred H. Osgood, comprises "A biological reconnaissance of the base of the Alaska peninsula." The Farmers' Bulletins are: "The relation of coyotes to stock raising in the West" (No. 226), by D. E. Lantz, and "Game laws for 1904" (No. 207), by T. S. Palmer. The articles in the Yearbook are entitled "The relation of birds to fruit growing in California," by F. E. L. Beal, and "Benefits which the farmer may derive from game protection," by T. S. Palmer. Following are the titles of the circulars: No. 43, "Definitions of open and close seasons for game;" No. 44, "Directory of game officials;" No. 45, "Warning against trespass on the Breton Island Reservation;" No. 46, "Directions for collecting bird stomachs;" No. 47, "Recommendations of State game commissioners and wardens." The bulletins are entitled: No. 18, "Distribution and migration of North American warblers," by W. W. Cooke; No. 19, "Hunting licenses, their history, objects, and limitations," by T. S. Palmer; No. 20, "Coyotes in their economic relations," by D. E. Lantz. Reprints of the reports of the Chief for 1903 and 1904 were issued. The reprints of bulletins include the following: No. 6, "The common crow of the United States," by W. R. Barrows and E. A. Schwarz; No. 9, "Cuckoos and shrikes in their relation to agriculture," by F. E. L. Beal and Sylvester D. Judd; No. 10, "Life zones and crop zones of the United States," by C. Hart Merriam; No. 13, "Food of the bobolink, blackbirds, and grackles," by F. E. L. Beal; No. 15, "The relation of sparrows to agriculture," by Sylvester D. Judd; No. 17, "Birds of a Maryland farm," by Sylvester D. Judd. Twelve reprints of Yearbook articles are as follows: "How birds affect the orchard" (three issues); "Audubon societies in relation to the farmer;" "Birds as weed destroyers" (two issues); "Some new facts about the migration of birds;" "The food of nestling birds;" "Four vanishing game birds;" "The bluejay and its food;" "The meadow lark and Baltimore oriole;" "Four common birds of the farm and garden."

OUTLINE OF WORK FOR THE YEAR 1906.

GEOGRAPHIC DISTRIBUTION.

Field work in California, New Mexico, and Colorado will be continued during the year 1905–6 on much the same lines as in the past.

In Texas the field work for mapping faunal areas has been practically completed, and final reports are being prepared.

No field work in Alaska is contemplated before the spring of 1906, as the time of the assistant in charge of that work will be devoted to the elaboration of material already gathered.

The reconnaissance of the Mackenzie Basin has been completed, and a report upon the region is now nearly ready.

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ECONOMIC ORNITHOLOGY AND MAMMALOGY.

A preliminary report on the relation of birds to the boll weevil in Texas, giving the results of observations in the field and of the examination of the stomachs of species supposed to feed upon the weevil, has been published. The work will be continued in cooperation with the Bureau of Entomology with a view to ascertain the part birds play in limiting the increase of this destructive insect.

Investigation of the food of California birds will be continued, and it is believed that the large amount of material now in hand will suffice for a very complete report upon the economic work of birds in a considerable portion of this important agricultural State.

One of our most valuable birds from an economic point of view is the rose-breasted grosbeak, which not only eats the Colorado potato beetle but apparently prefers this insect to all other food. A considerable number of stomachs of this bird and the allied species have been gathered, and they are now being examined with a view to the preparation of a bulletin on the subject.

During the past year experiments have been inaugurated to ascertain a practicable method of limiting, or altogether preventing, the damage to sheep by coyotes. So destructive are these animals in some sections of the West that the sheep industry has been abandoned as unprofitable. During the coming season the experiments will be continued, and it is believed that by means of wire fencing, at moderate cost, sheep may be safely inclosed, the services of herders largely dispensed with, and the quality of the pasturage greatly improved.

Further work will be done with a view to the discovery of means of preventing the damage to fruit trees by meadow mice, a most destructive group of small mammals whose ravages over much of the country are frequent and serious. So numerous are these little rodents in some regions that all ordinary means of destroying them by traps and poisons have proved inadequate, and it is thought that an effective virus may be discovered and the animals destroyed by inoculation. It is hoped to make experiments in this direction in cooperation with the Bureau of Animal Industry.

Much work has been already done with a view to the discovery of means of limiting the serious ravages of prairie dogs and ground squirrels. Further experiments will be tried, and it is hoped that a bulletin on the subject can be made ready for publication during the year.

IMPORTATIONS.—It is important that inspection service at ports of entry should be made more effective. There is a strong tendency to introduce exotic species, and constant vigilance is necessary to prevent the importation of such as may become pests. Birds and mammals liberated in a new country are likely to multiply beyond control, and often develop injurious traits not displayed in their native home. As soon as means are provided for the purpose, therefore, a more thorough system of inspection will be established so that the dangers that constantly threaten from this source may be reduced to a minimum.

INTERSTATE COMMERCE IN GAME.—Field work will center largely in Kansas, North Carolina, and Virginia. The game law passed by Kansas this year makes cooperation with State authorities possible,

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and investigation will be made of methods of game shipments, markets for such shipments, and the extent to which waterfowl are shipped in violation of the State law and the Lacey Act. Numerous violations of the Federal law have been reported to the Department from Virginia and North Carolina, and show the necessity for closer inspection in these States.

INFORMATION CONCERNING GAME.—There is a growing need for prompt and extensive circulation of publications on laws and judicial decisions relating to game, owing to the increasing activity in enforcement and the heavier penalties imposed. Two hundred and ninety-five game cases were tried in the Illinois courts in the year ending June 30, 1904, and 351 in those of New Jersey in the year ending October 31, 1904. This rigid enforcement of the game laws makes it important that the law shall be known to all. In addition to the usual bulletins and posters containing a summary of the provisions of the game laws in force, a new edition of Bulletin 16 will be published, containing digests of the current laws. Work will be continued on the index of decisions on game laws, begun last year. This index will contain a brief résumé and syllabus of each case. It will comprise 200 of the most important decisions and will probably soon be ready for publication.

SPECIAL INVESTIGATIONS.—Continuation of the preparation of the index of game laws undertaken in cooperation with the New York State Library will constitute a feature of the year's work. Investigation of the subject of private game preserves also will be continued. The increased number of these and the decrease of game in various localities have given impetus to the propagation of game for restocking purposes. Owing to the severity of recent winters the demand for quail far exceeded the available supply. A study will be made of the conditions under which game may be propagated successfully and in adequate quantity.

RECOMMENDATIONS.

In submitting estimates for the fiscal year 1907, the following recommendations are made:

(1) That an increase of $1,700 in the statutory roll be granted for the purpose of making the salary of the Chief conform more nearly to that of other Bureau heads, and of employing a stenographer and typewriter, whose services are necessary on account of the constantly increasing work of the Bureau.

(2) That an increase of $7,500 in the lump appropriation be granted to provide for the greatly increased demands for information and field work in locating the boundaries of the crop belts; for work on geographic distribution, economic ornithology and mammalogy, and game preservation, and for special investigations in connection with depredations of wolves on stock, and of rabbits, ground squirrels, and other injurious rodents on crops. A portion of the above sum, not to exceed $1,000, is desired for the payment of inspection fees for the entry of foreign birds and animals.

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REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ACCOUNTS AND DISBURSEMENTS,
Washington, D. C., September 29, 1905.

SIR: I have the honor to submit herewith a report of the work of the Division of Accounts and Disbursements for the fiscal year ended June 30, 1905.

Very respectfully,

F. L. EVANS, *Chief of Division.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

APPROPRIATIONS, EXPENDITURES, ETC.

The total appropriations for the Department for the year ended June 30, 1905, amounted to $6,094,540, not including $720,000 appropriated for the several State agricultural experiment stations. Of this sum ($6,094,540) $5,388,095.61 was disbursed prior to the close of the year, leaving a balance of $721,444.39, the major part of which is covered by liabilities. Supplemental accounts for the years 1903 and 1904 were also paid, amounting to $343,985.83. The unexpended balances for the year 1903, amounting to $281,615.16, were finally covered into the Treasury on June 30, 1905.

There were received, audited, and paid 44,127 accounts, as follows: Weather Bureau, 11,444, amounting to $1,393,422.11; Bureau of Animal Industry, 8,943, amounting to $1,511,579; all other Bureaus and Divisions, 23,740, amounting to $2,561,800.68, a total of $5,466,801.79. In payment of these accounts 50,321 checks were drawn on the Treasury at Washington and subtreasuries at New York and at Chicago.

LOST CHECKS.

During the year 218 checks were lost in transit through the mails or by the payees. Of this number 215 were in payment of salaries of Weather Bureau employees for the month of February and were destroyed by fire in a wreck on the Baltimore and Ohio Railroad, near Cumberland, Md., on the morning of March 1 last. As nearly all of the employees in whose favor these checks were drawn depend upon their monthly salary for their actual living expenses, they were

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more or less seriously embarrassed and were compelled to borrow money from banks or private individuals at excessive rates of interest to tide them over the period of six months which must elapse under the law before a duplicate check may be issued. It is believed that the present law is too exacting, not to say unjust, in the matter of duplicate checks, and the statute should be modified so as to allow the issuance of duplicate checks immediately after the filing of the necessary affidavit and bond of indemnity. In this way the interests of the Government would be amply protected and the cause of many unnecessary hardships would be removed. It is not the delay under the present law in issuing a duplicate check that affords protection, but the bond of indemnity to the Government.

REQUISITIONS, LETTERS, REQUESTS, CONTRACTS, AND LEASES.

One hundred and ninety-nine requisitions were drawn on the Treasury, aggregating $5,512,129.51.

The number of requisitions issued for supplies was 14,736.

The number of letters of authorization for travel was 1,987.

The number of letters written and received in the ordinary transaction of business was 76,699.

The number of requests for passenger transportation was 7,807.

The number of requests on the Quartermaster-General for the transportation of Government property was 2,075.

The number of leases and agreements executed and in effect was 400.

The number of contracts for supplies, etc., was 208.

The amount expended for telegraphing and telephoning by the Weather Bureau, including the West Indian cable service, was $217,902.04.

NEW BUILDINGS.

The total amount expended from the appropriation of $1,500,000 for the erection of new laboratory buildings to September 1, 1905, was $159,084.41. Of this amount, $141,000 was paid for excavating for foundation and for the services of architects; the balance of $18,000 was paid out in salaries.

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APPROPRIATIONS, DISBURSEMENTS, AND UNEXPENDED BALANCES FOR THE FISCAL YEAR 1905.

The table following shows for the fiscal year the amounts appropriated, disbursed, and unexpended:

Monthly check statements, settlement of accounts, etc., 1905.

Object.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$482,300	$470,068.56	$12,281.44
Bureau of Animal Industry:			
Expenses	1,275,000	1,285,589.33	139,410.67
Deficiency appropriation	150,000		
To eradicate contagious diseases of animals, 1904–5	250,000	245,242.59	4,757.41
Bureau of Plant Industry:			
Vegetable pathological investigations	150,000	139,212.58	10,787.42
Rent of quarters	2,500	2,450.00	50.00
Pomological investigations	43,500	39,725.27	3,774.73
Botanical investigations and experiments	67,500	61,057.31	6,442.69
Grass and forage-plant investigations	42,500	39,277.57	3,222.43
Experimental gardens and grounds	25,000	24,112.28	887.72
Greenhouses, 1904–5	25,000	24,995.32	4.68
Arlington Experimental Farm	20,000	19,564.22	435.78
Tea-culture investigations	10,000	7,645.00	2,355.00
Purchase and distribution of valuable seeds	290,000	258,889.00	31,111.00
Investigating production of domestic sugar	7,500	6,610.47	889.53
Bureau of Forestry:			
Forestry investigations, including $15,500 for rent of building	388,000	318,960.69	69,039.31
Testing timbers, Louisiana Purchase Exposition, St. Louis, Mo. (deficiency act)	10,000	9,986.90	13.10
Bureau of Chemistry: Laboratory	135,000	126,093.08	8,906.92
Bureau of Soils:			
Soil investigations, including $6,000 for rent of building	170,000	154,402.77	15,597.23
Entomological investigations	70,000	67,132.11	2,867.89
Cotton boll weevil investigations, 1904–5	250,000	204,744.64	45,255.36
Biological investigations	34,000	31,421.91	2,578.09
Publications	210,000	194,275.74	15,724.26
Collecting agricultural statistics	139,500	128,715.07	10,784.93
Library	10,000	7,915.39	2,084.61
Contingent expenses	37,000	34,394.14	2,605.86
Agricultural experiment stations ($810,000) [a]	90,000	87,227.29	2,772.71
Nutrition investigations	20,000	17,869.16	2,130.84
Irrigation investigations	67,500	54,791.62	12,708.38
Public-road inquiries	35,000	30,961.61	4,038.39
Building	250,000	100,415.35	149,584.65
Total	4,756,800	4,198,746.97	563,053.03
WEATHER BUREAU.			
Salaries	180,440	180,231.25	208.75
Fuel, lights, and repairs	8,000	7,648.40	351.60
Contingent expenses	10,000	8,400.85	1,599.15
General expenses, salaries	1,064,300	918,948.78	145,351.22
General expenses, miscellaneous			
Buildings	48,000	47,010.80	989.20
Cables and land lines	27,000	24,764.91	2,235.09
Total, Weather Bureau	1,337,740	1,187,004.99	150,735.01
Grand total	6,094,540	5,380,751.96	713,788.04

[a] Of this amount $720,000 was paid directly to the experiment stations from the Treasury Department.

The check statements submitted by the Treasury and subtreasuries were compared with the checks issued by this Division, and the amounts verified. The annual report to Congress of all expenditures of the Department for the year 1904 was prepared in this Division, and submitted through the Speaker of the House of Representatives in conformity to law. Compliance with this law, which relates only to the Department of Agriculture, involves a large amount of clerical work, and accomplishes apparently nothing of practical value, inas-

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much as the report is rarely ever referred to after being printed, the expense for which is over $5,000, and the number of copies printed 1,620. The report is practically an abstract from the books of the Department, and if needed by Congress for any special purpose could be furnished in a reasonable time. The discontinuance of this report would mean a large annual saving to the Government, and a recommendation to Congress for the repeal of the statute would be in the interest of economy.

ANNUAL SUPPLIES.

Annual supplies for the use of the various branches of the Department were freely advertised for in the usual manner and at a uniform time with the other Executive Departments, and contracts were made covering as nearly as practicable all the lines of supplies needed during the year. The method pursued by this Department in advertising for supplies and in obtaining competition thereon is thought to accomplish the object sought very fully. Advertising is done not only through the medium of daily newspapers in the large cities for a certain period before the supplies are needed, but hundreds of copies of the advertisement in the form of a printed slip are mailed to known dealers in the wares required. All bids are submitted to and are passed upon by a board of award acting under the instructions and by the authority of the Secretary. Supplies aggregating an amount less than $50 may, under the act of March 1, 1899, be purchased in the open market. In this connection it may be well for the information of those interested to publish here the Secretary's order relating to this act, which order is rigidly enforced:

GENERAL ORDER No. 21.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., March 10, 1899.

To the Chiefs of Bureaus and Divisions and other officers, agents, and employees of the Department of Agriculture:

Your attention is invited to a paragraph in the act of Congress approved March 1, instant, making appropriations for this Department for the fiscal year ending June 30, 1900, reading as follows:

"That hereafter section thirty-seven hundred and nine of the Revised Statutes of the United States shall not be construed to apply to any purchase or service rendered in the Department of Agriculture when the aggregate amount involved does not exceed the sum of fifty dollars."

The effect of this enactment is to place upon the Secretary of Agriculture the entire responsibility of determining to what extent, if any, the principles of competition shall be applied in any case where the amount involved is fifty dollars or less.

The advantages of honest competition are, in most cases, too great and too distinctly manifest to be neglected. You are, therefore, advised that hereafter, as heretofore, it will be the policy of the Department to avail itself of these advantages in all cases where competition is practicable. The requirements of paragraph 9*b* of the Fiscal Regulations will remain in full force and effect, except in so far as they are modified by the next following paragraph (9*c*).

The Chief of the Supply Division in the Department and the Chief of the Division of Supplies in the Weather Bureau, who are the purchasing officers of the Department, and whose duty it is to prepare all requisitions, are hereby directed to enforce a strict compliance with the regulations in respect to purchases. *Competition must be secured in every case when practicable.*

It should be especially noted that purchases and services are exempted from the operations of sec. 3709 *only* when the *aggregate* amount involved does not

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exceed fifty dollars. It would, therefore, be clearly an evasion of the law to divide a purchase for the purpose of keeping below the limit named. Congress has granted the Department all that was asked for in this respect, and good faith demands that the representatives of the Department obey the statute in its letter and spirit.

The Chief of the Division of Accounts, for the Department, and the assistant chief, on the part of the Weather Bureau, may, therefore, before passing upon proposed expenditures, require evidence showing that the law and the regulations have been complied with in all particulars.

JAMES WILSON,
Secretary of Agriculture.

PUBLIC MONEYS RECEIVED FROM VARIOUS SOURCES.

There were received from various sources and deposited in the Treasury to the credit of the proper funds the following sums:

Sales of condemned property	$4,776.05
Sales of card index	315.87
Sales of publications, Weather Bureau	531.89
Telegraph-line receipts, Weather Bureau	2,130.77
Sales of American dairy products in Europe	167.64
Sales of experimental shipments of fruits	2,426.21
Sales of products, agricultural station, Hawaii	1,153.70
Sales of products, agricultural station, Porto Rico	1,013.62
Sales of products, agricultural station, Alaska	260.31
Sales of copies of the Library card index	16.03
Total	12,792.09

Beginning with July 1, 1904, the proceeds of sales of card index of agricultural literature were made available until used, instead of, as heretofore, lapsing with the fiscal year. The same applies to the sales of experimental shipments of fruits, etc., to Europe, beginning July 1, 1905.

In this connection it is thought desirable to explain the method pursued in receiving and disposing of the moneys pertaining to the several funds.

The proceeds of "condemned property" are covered into the Treasury to the credit of "Miscellaneous receipts," under section 3618 of the Revised Statutes.

The moneys received from the sale of "card index of agricultural literature" prepared by the Office of Experiment Stations is covered into the Treasury to the credit of that appropriation, as provided by the appropriation act.

Proceeds of "dairy and other farm products of the United States" are covered into the Treasury to the credit of the appropriation "Expenses, Bureau of Animal Industry," by authority of said act.

All proceeds of "experimental shipments of fruits and vegetables to foreign countries" are deposited in the Treasury to the credit of the appropriation "Pomological investigations," as provided by that act.

Moneys derived from the sales of certain "publications" issued by the Weather Bureau are deposited in the Treasury to the credit of the appropriation "General expenses" of that Bureau, under section 227 of the Revised Statutes.

"Seacoast telegraph line receipts" are covered into the Treasury under act of March 3, 1883 (22 Stat. L., 616).

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Proceeds of the "card index" prepared by the Library are deposited in the Treasury to the credit of the Library fund of the Department, provided for by the appropriation act.

In acknowledgment of each deposit of funds the Treasurer issues to the depositor a duplicate certificate of deposit. The number of this certificate is entered as part of the transaction, and the certificate is pasted in the journal opposite the entry.

These moneys are forwarded to the Division of Accounts and Disbursements, from the various Bureaus, Divisions, and Offices of the Department, accompanied by a letter, or specially printed form, in duplicate, explaining from whence the money was derived. The duplicate is receipted by the Chief of this Division and returned to the sender. The original is placed in the files of this Division as a voucher. The amount received is entered in a book with a description of the transaction copied from the letter of transmittal. If in the form of cash or postal money order, it is so stated in the entry, and if by check or draft a minute description is given, with name of payor, payee, indorser, name of bank, number and date of check, etc. The law requires that money so received shall be deposited in the Treasury within thirty days after its receipt by a Government officer. The practice in this Office is to deposit all sums as soon as practicable after they are received, unless of an insignificant amount. The Chief of this Division, having no authority to do otherwise, accepts the statements accompanying sums of money submitted to him, assuming them to be in strict accordance with the facts.

ACCOUNTS FOR THE FISCAL YEAR 1903 FINALLY CLOSED.

The unexpended balances of the appropriations for the year 1903 were finally covered into the Treasury on June 30, 1905, and carried to the surplus fund, as shown on page 323.

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Amount of unexpended balances for fiscal year 1903 turned into the Treasury.

Object.	Amount appropriated for 1903.	Amount disbursed.	Amount unexpended.
Salaries	$465,500	$450,976.17	$14,523.83
Library	8,000	7,635.11	364.89
Contingent expenses	37,000	42,916.14	83.86
Urgent deficiency, contingent	6,000		
Vegetable pathological investigations	105,000	103,646.28	1,353.72
Vegetable pathological investigations, 1902-3	5,000	4,130.02	869.98
Pomological investigations	30,000	29,606.83	393.17
Botanical investigations and experiments	55,000	54,900.42	99.58
Grass and forage plant investigations	30,000	29,527.41	472.59
Experimental gardens and grounds	25,000	24,935.74	64.26
Arlington Experimental Farm	15,000	14,998.81	1.19
Investigating production of domestic sugar	5,000	4,065.10	934.90
Tea-culture investigations	10,000	7,500.10	2,499.90
Purchase and distribution of valuable seeds	270,000	266,229.81	3,770.19
Forestry investigations	254,000	244,781.68	9,218.32
Laboratory	60,500	59,518.91	981.09
Soil investigations	130,000	128,408.15	1,591.85
Entomological investigations	37,500	37,485.44	14.56
Entomological investigations, 1902-3	8,000	7,989.42	10.58
Biological investigations	26,000	25,616.80	383.20
Biological investigations, 1902-3	2,000	1,949.61	50.39
Urgent deficiency publications	200,000	190,961.49	13,038.51
	4,000		
Collecting agricultural statistics	94,200	94,023.27	176.73
Agricultural Experiment Stations ($796,000 [a])	76,000	77,552.69	333.31
Amount of deposits	[b] 1,886		
Nutrition investigations	20,000	19,901.12	98.88
Irrigation investigations	65,000	62,201.12	2,798.88
Public-road inquiries	30,000	29,996.13	3.87
Foreign-market investigations	6,500	6,140.02	359.98
Silk investigations	10,000	7,133.32	2,866.68
Expenses, Bureau of Animal Industry	1,660,000	1,444,113.05	215,886.95
Urgent deficiency, Bureau of Animal Industry	500,000		
Total	3,752,086	3,478,840.16	273,245.84
WEATHER BUREAU.			
Salaries	165,260	164,927.46	332.54
Fuel, lights, and repairs	10,000	9,964.65	35.35
Contingent expenses	8,000	7,806.38	193.62
General expenses	915,500	428,219.24	1,280.76
		480,377.71	5,622.29
Meteorological observation stations	60,000	59,628.24	371.76
Buildings	50,000	49,467.00	533.00
Cables and land lines	40,000	40,000.00	----------
Storm-warning stations, Glenhaven and South Manitou Island, Mich	15,000	15,000.00	----------
Total, Weather Bureau	1,263,760	1,255,390.68	8,369.32
Grand total	5,015,846	4,734,230.84	281,615.16

[a] Of this amount $720,000 was paid directly to the experiment stations from the Treasury Department.

[b] Receipts from sales of certain products of Alaska, Hawaii, and Porto Rico experiment stations.

IMMEDIATELY AVAILABLE APPROPRIATIONS.

The following sums were made immediately available for the year 1905:

Vegetable pathological investigations, $2,000, of which sum nothing was expended prior to the ensuing fiscal year; laboratory, $15,000, from which payments were made amounting to $1,536.46 before the ensuing year; biological investigations, $1,000, and publications, $1,000, from which sums no expenditures were made until after the first of the ensuing year.

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TRANSFER OF SALARIES.

The salaries of certain employees heretofore paid from lump-sum appropriations were by the act of March 3, 1905, transferred to the statutory rolls of the several Bureaus and Divisions to which they pertained, thus largely increasing the following statutory rolls, to wit:

Weather Bureau	$10,990
Bureau of Plant Industry	94,430
Bureau of Forestry	44,820
Bureau of Chemistry	9,280
Bureau of Entomology	3,960
Bureau of Statistics	39,900
Division of Publications	83,730
Library	2,800
Office of Experiment Stations	29,040
Office of Public Roads	12,340
Total	331,290

The statutory rolls of the Bureau of Animal Industry, Bureau of Soils, and Division of Biological Survey were reduced by the transfer of certain scientists therefrom to the lump-sum rolls of these Bureaus.

TELEPHONE SERVICE.

The Department's interior telephone system continued its reputation for excellence during the year, at an expense for repairs of less than $2. Forty additional telephones were placed on the switchboard during the year, thus increasing the number from 60 to 100, the full capacity of the switchboard. This interior system, which is owned by the Department, has fully paid for itself in the saving of rental formerly paid to the local telephone company and in messenger service, and has clearly demonstrated the practicability of an intercommunicating departmental system by means of tie lines connecting all the Government establishments in the city. Such a telephone system is feasible, and should be established in the interest of economy and business methods.

BUILDINGS UNDER LEASE IN THE DISTRICT OF COLUMBIA.

The following comparative statement shows an increase in the total amount appropriated for rental for 1906 over 1905:

Bureaus and divisions.	Amount appropriated for rental.	
	1905.	1906.
Bureau of Chemistry, laboratories and offices, 200-202 Fourteenth street SW.	$2,800	$2,800
Bureau of Animal Industry, laboratories and offices, 1362 B street SW	1,800	2,500
Bureau of Soils, laboratories and offices, 208-214 Thirteenth street SW	6,000	4,000
Bureau of Forestry, offices, Atlantic Building, 930 F street NW	15,500	25,000
Bureau of Plant Industry:		
Vegetable pathology and physiology laboratories and offices, 1306 B street SW	3,000	6,000
Botanical investigations, laboratories and offices, 224 Twelfth street SW.	3,000	3,000
Grass and forage-plant investigations, offices, 1316 B street SW	2,000	2,500
Division of Publications, document rooms, 215 Thirteenth street SW	5,000	5,000
Bureau of Entomology, offices, 904 B street SW	720	720
Total	39,820	51,520

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The amount appropriated for rental has increased from $4,020 in 1897 to $51,520 for 1906.

ESTIMATES OF APPROPRIATIONS.

The estimates of appropriations for the year ending June 30, 1906, were prepared in this division, based upon recommendations made by the chiefs of the several bureaus and divisions, and after receiving the approval of the Secretary were forwarded to the Treasury in accordance with statutory requirements.

Appropriations and estimates for 1906.

Object.	Amount appropriated for 1906.	Amount estimated for 1906.
Salaries	$814,970	$490,000.00
Bureau of Animal Industry, general expenses	1,456,520	1,525,000.00
Bureau of Plant Industry:		
Vegetable pathological investigations	180,640	155,000.00
Pomological investigations	35,640	45,500.00
Botanical investigations and experiments	63,840	67,500.00
Grass and forage-plant investigations	39,660	42,500.00
Experimental gardens and grounds	20,320	30,000.00
Arlington Experimental Farm	20,000	20,000.00
Tea-culture investigations	8,500	10,000.00
Purchase and distribution of valuable seeds	242,920	290,000.00
Investigating production of domestic sugar	7,500	7,500.00
Forest Service, general expenses	793,180	463,000.00
Bureau of Chemistry: Laboratory, including $3,000 for table sirup	130,920	170,000.00
Bureau of Soils: Soil investigations, including $4,000 for rent of building	170,000	205,320.00
Bureau of Entomology: Entomological investigations, including $2,500 for moth investigations.	68,060	80,000.00
Bureau of Biological Survey, biological investigations	44,420	39,000.00
Publications	132,250	215,000.00
Bureau of Statistics, collecting agricultural statistics	98,800	139,500.00
Library	8,040	11,000.00
Contingent expenses	37,000	37,000.00
Agricultural experiment stations ($794,660) [a]	74,660	101,000.00
Nutrition investigations	20,000	20,000.00
Irrigation investigations	74,200	82,500.00
Public-road inquiries	37,660	45,000.00
Cotton boll weevil investigations	190,000	----------
Building	950,000	----------
Total	5,719,700	4,291,320.00
WEATHER BUREAU.		
Salaries	191,430	181,190.00
Fuel, lights, and repairs	10,000	10,000.00
Contingent expenses	10,000	10,000.00
Salaries, station employees	531,550	512,300.00
General expenses	562,010	592,000.00
Buildings	53,000	48,000.00
Cables and land lines	35,000	35,000.00
Total Weather Bureau	1,392,990	1,388,490.00
Grand total	7,112,690	5,679,810.00

[a] Of this amount, $720,000 is paid directly to the experiment stations from the Treasury Department.

INCREASE OF SALARY.

The salary of the assistant chief of this Division was increased by statutory enactment, to take effect on July 1, 1905, from $2,000 to $2,500, a most worthy and long-deferred promotion.

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SOLICITOR.

The designation of Law Clerk was changed by operation of law to that of Solicitor, to take effect on July 1, 1905, the duties and salary of the position remaining unchanged.

THE DIVISION SALARY ROLL INCREASED.

Four clerks and five classified laborers, with salaries ranging from $2,000 to $600 per annum, formerly detailed to this Division, were, by the appropriation act approved March 3, 1905, transferred to the statutory roll of the Division at the same salaries, to take effect on July 1, 1905. By the same act the laborers were placed in the classified service without further examination.

CONDITION OF WORK IN THE DIVISION.

The current work is practically up to date, with the exception of certain unimportant details. This result is accomplished only by severely taxing the endurance of the clerks, the force being inadequate to care for the great volume of work due to the constantly increasing appropriations. The number of clerks in this Division is only sufficient to keep up the work when all are present. If the number be reduced on account of absence for any cause double work must be done by those who remain on duty. This is an unfortunate situation, and is not calculated to secure the best results. An increase in the force and a reorganization of the personnel of the Division is strongly recommended on lines which will be specifically presented to you in another communication.

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REPORT OF THE EDITOR, DIVISION OF PUBLICATIONS.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF PUBLICATIONS,
Washington, D. C., September 25, 1905.

SIR: I have the honor to submit herewith, for your information and consideration, a report on the work of this Division for the fiscal year ended June 30, 1905, together with recommendations in regard to future operations.

Respectfully,

GEO. WM. HILL,
Editor and Chief.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

I have to report for the fiscal year just passed an increase in the work of this Division even more marked than that which characterized the year previous. As against 972 publications issued in 1904, there were 1,072 in 1905. New publications, excluding those issued from the Weather Bureau, amounted in 1904 to 379, and to 391 in 1905. At the same time it is to be noted that the total number of copies issued in 1905 was but slightly in excess of the total number of copies for the year previous. This resulted from an earnest effort to reduce the size of the editions, with a view to preventing waste. A comparison of the aggregate number of copies of all publications, including Farmers' Bulletins, printed in 1905 with the average for the five years ended with the fiscal year 1904 shows the result of this effort in a still more marked degree. The average number of publications issued annually during that five-year period was 748, and the average number of copies annually printed amounted to a fraction over 10,000,000, an average edition of 13,369 copies. The number of publications issued in 1905 amounted, as above stated, to 1,072, and the total number of copies of all publications printed in 1905 was 12,475,157, the average edition being 11,637 copies. Thus, in spite of the increase in the number of publications of almost 50 per cent, we have actually a decrease in the average editions of nearly 5 per cent.

Another striking evidence of the increase in the work of the Division is shown by comparison of the number of requisitions for printing issued during the fiscal year 1905 with the year previous. The figures for 1904 are: Requisitions drawn on the main printing office, 1,278; on the branch printing office, 3,446—total, 4,724. For 1905: Requisitions drawn on the main office, 1,485; on the branch office,

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3,654—total, 5,139. These figures are exclusive of work done for the Weather Bureau. It is gratifying in contemplating this very considerable increase in the work accomplished in the Division to note that it has been accomplished at a very slight increase in expense. Aside from the cost of such publications as the Yearbook and the Annual Reports and special reports printed as Executive documents and defrayed from special appropriations made by Congress, the total amount available in 1905 for the expenses of this Division and the cost of printing, exclusive of those just mentioned and of those of the Weather Bureau, was $400,640, an increase of $11,320 over the year 1904, or a fraction under 3 per cent. The fact that with every year the increase in work accomplished is greatly in excess proportionately of the increase in our expenses is an evidence of good management and of increased efficiency in the force under my control, to which I believe I may be permitted to call attention with considerable satisfaction.

ECONOMIES IN PUBLICATION WORK.

Although, as evidenced by figures already given, a considerable reduction has been effected in the size of the editions published, it seems as if we could do still more in this direction were the chiefs of our various Bureaus and Offices to second the efforts of this Division more earnestly by limiting the size of first editions. The fact does not seem to be so generally appreciated as it should be that, the plates of all of our publications being preserved by the Public Printer until their destruction is authorized by this Division, reprints may be had with comparatively little delay as occasion requires. There is a natural tendency to estimate at pretty high figures the probable miscellaneous demand. This, I think, can be considerably restricted under the system which provides for a reprint, available within a very few weeks, whenever the supply of any publication approaches exhaustion.

Mention should be made here of the operation of the amendment to the law authorizing the reprinting of documents to be sold by the Superintendent of Documents, under which that officer is authorized, with the approval of the Secretary, to reprint our publications, defraying the expense of such reprints from moneys received by him from the sale of such documents. Under the operation of this law several of our publications have been reprinted, aggregating over 35,000 copies during the year, which formerly this Department would have been called upon to supply.

A still further and more marked economy would be effected if Congress could be induced, as recommended in my last report, to adopt some amendment to the law which would make available for our use after the lapse of some fixed period a certain proportion of every unused Congressional quota of publications issued from this Department. At present, in spite of the large number of copies of publications issued by this Department, we are constantly obliged to refuse requests from persons who apply directly to the Department for them. In addition, frequent requests are made by Senators and Representatives to this Department for additional copies of publications of which they have exhausted the quotas assigned to them, although in many cases a large number of copies of these same publi-

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cations remains in the folding rooms of the Senate and House uncalled for by the Senators and Representatives to whom they have been assigned.

The cost of printing public documents has reached such large figures that it seems worth while to consider every means possible of extending the distribution of these documents to persons who will be benefited by them where such means can be adopted without increase of expense.

SALE OF DOCUMENTS.

Unquestionably the most direct method of effecting economy, both by reduction of expense and by prevention of the waste inseparable from any system of gratuitous distribution, would be to greatly extend the sale of public documents. The records of the Superintendent of Documents, to whose courtesy I am indebted for the advance figures for the fiscal year 1905, show that during that year there were sold from his office 68,000 copies of various public documents, of which 38,124 emanated from this Department. The total number sold by him in 1904 was 47,800, of which 31,860 emanated from the Department of Agriculture. Owing to the low average cost of the publications of this Department, by comparison with those of other Departments, the sum received for the publications of this Department was much less than the amount received for the publications of all the other Departments. The amount received in 1905 for publications of the Department of Agriculture was $4,836.85, and for the publications of all other Departments $12,163.15, making a total of $17,000. While, by comparison with the enormous gratuitous distribution, the number of publications sold, as above, is insignificant, the fact, nevertheless, that such sales were made in the face of a widespread gratuitous distribution affords evidence that the sale of public documents could be greatly extended. It is obviously true that were our publications sold at even a very trifling figure a very great deal of waste in the distribution would be prevented and a very large sum would in the aggregate be available for reprinting those publications for which a continuous demand exists, and it would be no longer necessary for anyone to go without a Government publication of which he had need.

EDITING MATTER IN THE PROOF.

In some of my previous reports your attention has been directed to the great number of alterations made in the proof of matter ordered printed for the various Offices of the Department, with the result of greatly increasing the cost of composition. While there are some cases where some considerable alteration of the original text is unavoidable, by far the greater number of such alterations could be avoided by thoroughly editing the manuscript before it goes to the printer. It seems, however, very difficult to change the habit complained of, and I take this occasion to place on record your latest order upon this subject.

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GENERAL ORDER NO. 3—SUPPLEMENTARY.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 23, 1905.

TO CHIEFS OF BUREAUS, DIVISIONS, AND OFFICES:

My attention is again called to the great number of alterations made in the proof of matter ordered to be printed by the various offices of this Department, and I once more remind Chiefs of Bureaus, Divisions, and Offices that no matter of any description should be submitted for publication until the same has been carefully examined and revised and is in the precise words in which it should be printed. Editing in the proof presupposes neglect in the preparation of the original copy and can not be allowed. This order applies also to work done in the branch printing office in this Department, where vexatious and unnecessary alterations in blanks, forms, etc., frequently delay the operations of the office.

Every effort is being made in all Departments of the Government to practice economy in printing. You need not be told that editing matter in the proof is costly and extravagant. It becomes doubly so in the case where typesetting is done by machinery—a method now frequently adopted.

I have instructed the Chief of the Division of Publications, who is charged with the supervision of all the printing for the Department, to see that this order is rigidly observed.

JAMES WILSON, *Secretary.*

INDEXING DEPARTMENT PUBLICATIONS.

I have on previous occasions called attention to the urgent need of a general index to all Department publications, by which all information available for distribution may be reached with dispatch and certainty. Until this year it was found impossible with the force and facilities at my command to carry on this work on a scale commensurate with its importance, and we have been compelled to get along with indexes to certain classes of publications for which the need of an index was most urgent. During the past year a new section, charged with this special duty, has been organized in the Division, and it is believed that with the assistance of a special expert index clerk, provision for which is made in the estimates I have the honor to submit to you, and a small clerical force, the gentleman in charge of that section, Mr. C. H. Greathouse, will be able to carry on this work.

The inquiries of Congressmen and other public men and of practical farmers, and the demands for sets of books for libraries, often require that a complete showing of everything available in the Department on a given subject be made up, and it is impracticable to do this without the aid of such a comprehensive index. It is obviously unsafe to rely upon the memory of any person for such information, and no index nor recording device in existence meets the demand. Accordingly, a card index for the purpose has been prepared and is being perfected as rapidly as the conditions will permit.

A similar index which shall show all information on any subject to be found in the Department publications, whether available for distribution or not, will be greatly useful.

It is often important in editing a manuscript submitted for publication to know what has already appeared on its subject in the Department publications. Moreover, such an index would naturally be useful to the several Bureaus in the pursuance of their studies and the preparation of results for publication. Also, it should be useful

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to students of agriculture and writers on agricultural subjects everywhere.

Many important discussions in the reports, Yearbooks, and other publications of the Department, now practically beyond the reach of investigators, will be brought to light by this index. Instances of this kind are discussions on grafting of citrus fruits, in the Yearbooks of 1895 and 1896; and formaldehyde as a disinfectant, in the Yearbook of 1896; starch production from yautias, in Porto Rico Bulletin No. 6; butter, history, commerce, and manufacture, in the Animal Industry Report for 1903; and soil surveys in many parts of the country, published in the Field Operations, Bureau of Soils.

FARMERS' BULLETINS.

The total number of Farmers' Bulletins printed during the year was 388, of which 24 were new publications and 364 reprints. The total number of copies printed was 5,930,500. The Congressional distribution amounted to 4,782,643 copies. One feature of this Congressional distribution deserves to be specially noted, and that is that the proportion of Senators and Representatives failing to use their quotas is very much less than it used to be. While doubtless there is still a large number of Congressmen who do not distribute all their bulletins in their own districts, there are very few of them who do not contribute from their quotas to the needs of colleagues who find their own quotas insufficient. The law provides that four-fifths of the total number of Farmers' Bulletins printed shall be held subject to the order of Senators, Representatives, and Delegates, but that all such bulletins not called for on or before the 31st day of May in each fiscal year shall revert to the Secretary of Agriculture and be available to him either for miscellaneous distribution or in making up Congressional quotas for the next fiscal year. Under your instructions this surplus has generally been disposed of in making up Congressional quotas for the next fiscal year. It would probably be more satisfactory if this reversion should take effect earlier, say on the 1st of April, as is the case with the seeds, and were the Secretary empowered to use the surplus as at present, omitting the provision "for the next fiscal year." In the great majority of cases the Congressmen who make the most use of their Farmers' Bulletins exhaust their quotas before April 1. The redistribution of the surplus as early as that date would be more advantageous than after the 1st of July following. The fact that the number of Farmers' Bulletins left over from the 1st of July last was much less than the year previous has resulted in a reduction in the Congressional quota of the current fiscal year from 15,000 to 14,000 copies.

ILLUSTRATIONS.

At the time the illustration work was assigned to this Division it was placed practically under the immediate charge of the assistant chief, Mr. Jos. A. Arnold. The continued increase in this line of work made it necessary to relieve him of this supervision, and on October 1, 1904, it was placed under the immediate supervision of Mr. L. S. Williams, the chief photographer of the Division. With

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the additional room assigned to the use of this Division for its illustration work and the enlarged equipment for the photographic studio, a great deal of work has been accomplished. The total number of drawings made by the artists and draftsmen in this section during the year amounted to 1,015. These drawings were covered by 107 requisitions. The total number of illustrations appearing in publications was 1,684. This, of course, does not include reprints. The greatest increase, however, in the illustration section has been in photographic work. In this connection, it should be stated that the superior facilities now possessed by this Division for work of this character seem to have attracted a considerable amount of such work from other Bureaus and Divisions. This concentration of work of this character, however, is obviously in the direction of efficiency and economy, and should therefore be encouraged as far as our facilities will permit. There is no other line of work which permits of so much waste in material. The more it is concentrated under one responsible head, the greater economy will there be in material used. Under the heading "Statistics of publication work" will be found a detailed statement of the illustration work for the year. From these illustrations 1,976 electrotypes have been furnished to persons outside the Department, mainly representing magazines and journals, in response to 198 requests. This is under an arrangement with a local firm which supplies these duplicates at a very reasonable rate, making their own collections for the cost, so that it is not necessary for any money to pass through the hands of this Division. In the same way a very large number of lantern slides have been duplicated, at the cost of the parties ordering them. A considerable demand exists for them on the part of farmers' institute workers and others, for illustrated lectures.

DOCUMENT SECTION.

The Department Editor, as Chief of the Division of Publications, is charged with the supervision of the distribution of the Department's publications, under section 92 of the act of January 12, 1895, providing for public printing, binding, etc., which says:

> Government publications * * * shall be distributed by a competent person detailed to such duty in each Department by the head thereof. He shall keep an account in detail of all publications received and distributed by him. He shall prevent duplication, and make detailed report to the head of the Department, who shall transmit the same annually to Congress.

In this duty he has the assistance of an employee in the Weather Bureau, having supervision over the distribution of Weather Bureau publications only, and an assistant in charge of the document section directing the distribution of all other publications issued by the Department. To comply with the provisions of the law governing this distribution involves a great deal of labor, not only in actually handling the documents, but in replying to correspondents, keeping card indexes to prevent duplication, preparing registration lists for delivery to the post-office with the more important documents, and in other incidental clerical work, so that in addition to the 55 employees whose entire time is devoted to the manual labor of mailing the documents, an equally large clerical force is required to properly conduct the activities of the document section.

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On the 1st of July, 1904, there were 3,119,753 publications in the document section, and there were received during the current year 11,390,035 documents, of which 6,087,973 were Farmers' Bulletins, and 5,302,067 miscellaneous publications other than Farmers' Bulletins. The distribution amounted to 12,089,653 documents, of which 4,896,287 were miscellaneous publications and 7,193,366 Farmers' Bulletins, 4,782,643 of the latter being distributed upon requests from Congressmen. These figures give indisputable testimony as to the amount of work devolving upon this office and the demand made upon the force employed in handling the Department's publications.

The balance on hand at the close of business June 30, 1905, consisted of 2,421,133 documents, of which 980,339 were miscellaneous publications and 1,440,794 were Farmers' Bulletins. This balance indicates, first, that with 1,100,000 Farmers' Bulletins less at the beginning of the current year than were in the possession of the Department on July 1, 1904, coupled with the constantly increasing demand for these publications, conservative action will be necessary in granting additional quotas for distribution under the franks of Senators, Representatives, and Delegates, lest the fund appropriated for the current year be found insufficient to supply the demand and there be a deficiency or a shortage of bulletins during the latter part of the year; and, second, that the editions of miscellaneous publications, over which the Editor exercises only an advisory supervision, are in many cases larger than the current demand, else there would not be an accumulation of 400,000 more documents than were on hand at the beginning of the year. It is true that a large number of new bulletins were received during the last month of the year, and it was not possible to distribute them before July 1, making a showing of a surplus greater than would have been the case had these bulletins been received from the Printing Office in time to effect the regular distribution before the close of the year. But it is also true that 310,500 books which were printed prior to July 1, 1904, were mailed to applicants for the same, and, adding this amount to the increment mentioned above, shows that 700,000 more miscellaneous publications were issued than were distributed during the year.

The new quarters, mentioned in last year's report, were ready for occupancy during the last week of December, 1904, and the document section was moved from the old Museum building and 1304 B street SW. to the new building, at 215 Thirteenth street SW., erected according to plans submitted by this office and rented for its use. The assembling of all the employees and storage rooms under one roof, and the accommodations provided in the new building, have permitted a more systematic arrangement of the work, a better organization of the force, and the introduction of facilities which were impossible under the old arrangement. The present quarters are eminently satisfactory, and the work in the document section has been conducted with greater ease and dispatch than was possible under the conditions previously existing. To handle the number of new publications noted above, to move and rearrange the storage room and offices for 120 people and over 3,500,000 documents, and to close the year with the work practically up to date, called for a devotion to duty and a persistency of effort that speak well for the force employed in the section.

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As a whole, too much praise can not be given for the faithful and laborious service which has been rendered on salaries incommensurate with the class of work and much below that paid to other employees of this and other Departments having the same responsibilities and performing equal labor. There is, of course, still room for improvement, and, while the system employed is believed to be satisfactory, there is much to be desired in the application of the same to certain branches of the work. It is believed that a persistent effort will remove the friction and reduce the delay which have been noted during the past year, and thus result in expediting the passage of orders and requests through the document section to an average of about two instead of three working days, which has been the best that could be accomplished during the past year. In this way the bulletins will be mailed to the applicants the day after the receipt of the requests.

The amount of clerical work performed will be more readily comprehended when it is remembered that there were 223,365 miscellaneous requests for publications received and complied with, to each of which a reply was sent, an order prepared, a frank written, and an index card made, and that in addition to this there were 30,830 letters requiring the signature of either the Secretary or the Chief of the Division prepared. Most of the documents shipped were forwarded by ordinary mail, but 36,223 packages were sent by registered mail, as it has been found desirable to insure delivery by adopting this method of transportation. In addition to the clerical work mentioned above, 300,000 addresses were prepared each month for the crop reports and monthly lists, a total of over 3,500,000 franks. During the twelve months additional work has been assigned to the document section from various Bureaus, Divisions, and Offices of the Department in the preparation of franks from extensive lists of persons engaged in special lines of agriculture, or from miscellaneous lists furnished by the different Divisions for particular publications of interest to persons engaged in particular lines of agricultural work. As the Department increases its activities, the work of this kind thrown on the document section necessarily increases also, and this year there were about 500,000 such addresses written. There has been no special increase in the force employed, although some changes have taken place owing to transfers, resignations, deaths, etc.; hence the work has been performed by practically the same force that was employed when the results attained were much less than those secured during the past fiscal year.

REPORTS ORDERED BY CONGRESS.

I subjoin a list of the reports published by Congressional order for the current fiscal year. Of these, the first eight are what are known as "regular" reports published pursuant to law, while the last three are printed in response to special resolutions. The cost of all these publications is defrayed by the Public Printer from his regular or special appropriations. It is not chargeable to the special printing fund of this Department.

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CONGRESSIONAL REPORTS PROVIDED FOR BY LAW.[a]

	Copies.
(1) Report of the Secretary of Agriculture for 1904 (preliminary report)	5,000
(2) Annual reports of the Department of Agriculture for the fiscal year ended June 30, 1904	6,000
(3) Yearbook of the Department of Agriculture, 1904	500,000
(4) Twentieth Annual Report of the Bureau of Animal Industry, for the year 1903	30,000
(5) Field Operations of the Bureau of Soils, 1903	10,500
(6) Sixty-one soil surveys (advance sheets)	276,000
(7) Letter from the Secretary of Agriculture, transmitting a statement of the expenditures in that Department for the year ended June 30, 1904	1,850
(8) Message from the President of the United States, transmitting a report by the Secretary of Agriculture relating to the operations of the Bureau of Animal Industry for the year ended June 30, 1904	1,850

CONGRESSIONAL REPORTS PROVIDED FOR BY SPECIAL RESOLUTION.

(1) Special Report on Diseases of Cattle	50,000
(2) Progress of the Beet-Sugar Industry, 1904	12,000
(3) Reprint of Bulletin No. 124, Office of Experiment Stations, Report of Irrigation Investigations in Utah	4,000

REPORT TO JOINT COMMITTEE ON PRINTING.

On March 10, 1905, the chairman of the Joint Committee on Printing of the Senate and House, Hon. T. C. Platt, addressed to the Secretary of Agriculture a communication based upon a clause in the act for appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1905, and calling attention especially to that portion of the resolution relating to the printing and binding of executive documents executed at the Government Printing Office and at the branch printing offices and binderies of the various Departments. In response to this communication a list was prepared of all the publications issued by this Department during the fourteen years ended June 30, 1905, giving the size of each edition, the cost of each publication (as far as possible), the manner of distribution, and the number, if any, left in the hands of the Department July 1 last. The letter accompanying the same, and the reply to the several interrogatories contained in the communication, were embodied in a letter addressed by you to Senator Platt, under date September 27, 1905. The importance to the publication interests of the Department of this inquiry suggests the propriety of embodying in this report the communication of the chairman of the joint committee, and, with your permission, your letter addressed to him in reply thereto.

UNITED STATES SENATE, COMMITTEE ON PRINTING,
Washington, March 10, 1905.

DEAR SIR: Your attention is called to the following clause in the act making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1905:

"That the Committee on Printing of the Senate, with three members of the present House of Representatives who are reelected to the next Congress, to

[a] The Annual Report of the Chief of the Weather Bureau, 1903–4, 4,000 copies, and Annual Report of the Office of Experiment Stations for the year ended June 30, 1904, 8,000 copies, were not issued until after the close of the fiscal year.

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be appointed by the Speaker of the present House of Representatives, shall constitute a Commission, and they or any subcommittee of said special joint Commission are hereby authorized to examine into the numbers printed of the various documents, reports, bills, and other papers published by order of Congress, or of either House thereof, and of the Congressional Record, and if, in their judgment, the conditions as they find them warrant remedial legislation, to report a bill at the next session of Congress making such reductions in the numbers and cost of printing and such changes and reduction in the distribution of said publications as they may deem expedient, with a report giving their reasons therefor; and that the said Commission is also authorized to investigate the printing and binding for the Executive Departments executed at the Government Printing Office and at the branch printing offices and binderies in the various Departments, and if, in their judgment, the conditions as they find them warrant remedial legislation, to report a bill at the next session of Congress making such reductions in expenses and imposing such checks as they may deem expedient, with a report giving their reasons therefor; and said Commission is further authorized to make any other investigations calculated, in their opinion, to reduce the cost of the public printing, and report the result thereof; and in making the inquiries required by this resolution said Commission shall have power to send for persons and papers, to administer oaths, to employ a stenographer to report its hearings, to call on the heads of Executive Departments and the Public Printer for such information in regard to the preceding matters as they may desire, to do whatever is necessary for a thorough investigation of the subject, and to sit during the recess of Congress. Any subcommittee may exercise the powers hereby granted to said Commission, and the expenses of said investigation shall be paid one half from the contingent fund of the Senate upon vouchers duly approved by the chairman of the Committee on Printing and one half from the contingent fund of the House of Representatives."

Especially is your attention called to that clause in the resolution relating to the printing and binding for the Executive Departments executed at the Government Printing Office and at the branch printing offices and binderies in the various Departments. The Commission are authorized to investigate this class of public printing and binding with a view to—

(1) A reduction in the expenses of printing and binding; and

(2) Imposing additional checks, if any shall be needed, on the said printing and binding.

Will you kindly furnish written answers to the following interrogatories:

(1) What reports, documents, or pamphlets are printed for your Department? (In furnishing this answer please use the accompanying blanks. Additional blanks may be had from the Committee on Printing.)

(2) Have you a branch or independent printing office in your Department?

(*a*) How many and what kind of presses are in use in the branch office? How many people are employed in the branch office, and how are they paid?

(*b*) Is this branch office under the charge of the Public Printer or under the charge of an official of your Department?

(*c*) To whom does the foreman in charge of the office look for his final orders to perform printing for the Department?

(*d*) Do all orders for printing pass through the hands of one responsible head, or do Bureau chiefs and others give orders directly? What is the definite process, if any, in vogue in your Department in this respect?

(*e*) Who furnishes machinery and material for the branch office?

(*f*) Is the maintenance of the branch office in your Department in the interest of economy and convenience; or, could not the work in such branch office be performed with equal advantage at the Government Printing Office?

(*g*) What portion of the expenditure in your branch printing office is paid from the credit given you by Congress in the annual appropriation bill, and what portion from the credit given the Public Printer, and on what principle is such division made?

(*h*) Have you a bindery in your Department? If so, is it under the control of the Public Printer? If not, who has charge and control of it? State the size of the plant and what class of work it does. Could the same work be done as well or better or more or less economically in the bindery of the Government Printing Office?

(3) Could not the annual report emanating from your Department be so edited or supervised as to include the substance of accompanying papers or reports of subordinates, so as to do away with the expense of printing so many parts to the report of the head of the Department; and so many subreports of

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Bureau chiefs, experts, and others attached to your Department? Can you allege any good reason why the personal name of such Bureau chief, expert, or attaché of your Department appearing on the title-page of such subreports adds to their value? What remedy do you suggest for this growing tendency to voluminous annual reports? This question refers not only to the appendixes to the reports, but to the accompanying papers and to the subreports themselves.

(4) Is not the number of copies of reports printed, including accompanying papers, in many cases larger than is necessary to meet actual needs? Please give in detail the distribution of the reports of your Department, and make suggestions as to how the number of copies may be reduced, if it can be consistently done with reference to the interests of the public service, stating the least number of the different sorts of reports that can be printed for the use of your Department.

(5) Can you suggest any better method of distributing public documents emanating from your Department than now exists?

(6) What other public documents, bills, resolutions, etc., are required by your Department to facilitate business in your Department, and to whom should they be sent for distribution?

(7) Does the experience of your Department suggest any changes in existing laws relating to the public printing and binding, or the distribution of public documents, that would be in the line of economy and in the interest of the public service? This commission would be pleased to receive from you any suggestions relating to the public printing and binding, and the distribution of public documents, as well as the printing of blanks, letter heads, and envelopes that would be called for under the most liberal construction of the resolution to which your attention has been called.

As early an answer as practicable will greatly oblige.

Yours, truly,

T. C. PLATT,
Chairman Joint Committee on Printing.

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., September 27, 1905.

Hon. T. C. PLATT,
Chairman Joint Committee on Printing.

DEAR SIR: I have the honor to submit a reply to your communication of March 10 last, relative to the printing and binding for this Department executed at the Government Printing Office and at the branch printing offices of this Department.

In answer to inquiry No. 1, I transmit herewith a full statement prepared on the blanks supplied for the purpose.

In answer to interrogatory No. 2, I say, yes. There are two branch offices in this Department, one in the main building and the other confined exclusively to the work of the Weather Bureau, and situated in the Weather Bureau building.

In reply to inquiry (*a*) I refer exclusively to the Weather Bureau branch printing office. (*a*) There are two Walter Scott & Co. lithograph presses, three cylinder presses, and two Gordon jobbers, making seven in all. There are 13 employees in the composing room and 13 employees in the press room (including lithographers). (*b*) The branch office in the main office is under the charge of the Public Printer. The branch office in the Weather Bureau is under the control of the Chief of the Bureau. (*c*) The foreman in charge of the branch office in the main office looks for his final orders to perform printing for the Department to Geo. Wm. Hill, the Department Editor and Chief of the Division of Publications, and the officer designated by me for this purpose under section 31 of the act providing for the public printing and binding and the distribution of public documents, approved January 12, 1895. The foreman in charge of the Weather Bureau branch office looks for his final orders to perform printing to the Chief Clerk of that Bureau. (*d*) All orders for printing to be performed by the branch office in the main office pass through the hands of Mr. Hill. No other person gives orders directly to the foreman in charge. All orders for printing in the Weather Bureau branch office pass through one responsible head, i. e., the Chief Clerk. (*e*) The Public Printer furnishes all machinery and most of the material to the branch office in the main office. Occasionally some material is furnished from the Department supplies. In the Weather Bureau branch office, on the contrary, both machinery and material are

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supplied from the Department's appropriation through the Division of Supplies. (*f*) I regard the maintenance of these branch offices in my Department as being emphatically in the interest of economy and convenience, and I consider that the work done in them could not be performed with equal advantage in the Government Printing Office; this is especially true in regard to the branch office of the Weather Bureau. (*g*) The entire expenditure in the branch office in the main office is paid from the credit given to the Public Printer for the use of this Department, while the expenditure of the Weather Bureau branch office is paid from the credit given to me by Congress for the Weather Bureau. (*h*) There is no bindery in this Department.

In answer to interrogatory 3: The annual report of the Department of Agriculture is prepared in accordance with the provisions of section 31 of the act for the public printing and binding already cited, and is issued in two parts. Part I contains purely business and executive matter, which it is necessary for the Secretary to submit to the President and to Congress, including my own report and the reports of the several chiefs of Bureaus, Divisions, and Offices of the Department, and two subreports. This Part I was comprised in 1904 in 560 pages, of which 30 pages are devoted to an index. I think it is evident from this fact that this portion of the report is carefully edited and supervised, so as to save time, space, and expense. Part II of my annual report consists of "such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be especially suited to instruct and interest farmers of the country, and to include a general report of the operations of the Department for their information." This portion of my report is also very carefully edited, and notwithstanding the steady increase in the work of this Department, the Yearbooks, as they are called, for 1903 and 1904 are less bulky than for any year since 1898. It is my belief that good reasons exist why the name of the chief or of the author should appear on the title page of the Department reports. Much of the matter appearing in the reports of this Department is technical and depends in a measure for its value upon the experience and standing in his profession of the author. Moreover he, not I, is responsible for the technical statements uttered.

The only remedy I can suggest to restrict the growing tendency to voluminous annual reports is that which I have earnestly tried to put in practice, namely, the exclusion of all reports not presenting matter which shall be not only interesting but valuable to the persons for whom it is designed, and I understand the head of a Department to have full discretion in this matter, and this I have made it a rule to exercise in the direction of economy. In this respect no additional legislation seems to be necessary.

In reply to interrogatory 4: Of Part I of my Annual Report 6,000 copies are printed, of which 3,000 are for the use of the Senate and House. The 3,000 copies assigned to the use of this Department could not be greatly curtailed. In regard to Part II, known as the Yearbook, I may state that the number placed at the disposal of this Department is, in spite of its great extension and growth, no larger than the number of the older annual reports placed at the disposal of my predecessors nearly twenty years ago, and when the edition was but three-fifths of the present size. In view of the very large number of persons collaborating with the Department in its work, and who are entitled to some recognition at my hands, I find the 30,000 copies of the Yearbook placed at my disposal to be quite too few, so that its distribution causes me considerable embarrassment. Almost all the copies of this book at my disposal are used to send to people who have by gratuitous services rendered to the Department become entitled to some favorable recognition, and the number of Yearbooks assigned to me is not sufficient for this purpose. The manner of distribution of the publications of this Department depends largely upon the character of the publications themselves. The more technical ones are issued in comparatively limited editions, not being designed for extensive or popular use. The first recipients of these publications are the newspapers, including the entire agricultural press of the country, libraries of agricultural colleges and stations, and a selected number of libraries, the list of which is carefully checked from time to time with that of the public depositories, to avoid duplication. A small number of these pulications is also sent to the Superintendent of Documents as soon as the publication appears, and when enumerated in the Monthly List of Publications, which we send to all persons who ask for it, the price as affixed by him is stated, with the further statement that all publications to which a

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price is affixed should be obtained from the Superintendent of Documents, to whom all remittances must be made. In this way a very large number of our more technical publications are sold by that officer, the proceeds being, under a recent law, available for reprinting our publications as the demand continues. It has been for several years the practice in this Department to issue moderate editions of all publications, whether technical or popular, with the exception of emergency circulars and Farmers' Bulletins, the distribution of which is conducted on a large scale from the first. The plates of all publications being held by the Public Printer as long as required, reprints are readily ordered if the demand for any particular bulletin continues after the first edition is exhausted. During the year 1905 the number of reprints of the various bulletins and reports of the Department was 592, the new publications issued amounting to 378. Of the more than 12,000,000 copies of all publications issued by the Department of Agriculture, and which include those specially ordered by Congress, 7,000,000 consist of Farmers' Bulletins, about 4,500,000 of which are distributed entirely upon the order of Senators, Representatives, and Delegates in Congress. Every effort is now being made in this Department to limit the editions of publications, and I am happy to be able to state that a comparison of the figures at the present time with the figures ten years ago will show a very great increase in the amount of work done proportionately to the money spent. I may state, however, that I have always felt it my duty to give the widest possible distribution to any valuable information resulting from the investigations of the Department's experts. The organic law creating this Department very properly lays as much stress upon the duty of diffusing as upon that of acquiring valuable information in the interest of the farmer.

In response to interrogatory 5: As long as the principle of a gratuitous distribution for Government publications is recognized, I can not think of any better method of distributing public documents emanating from this Department than now exists. We maintain no large lists to which all publications are sent, and everything possible is done to put our publications only in the hands of people who desire to use them, so far as the distribution is controlled by the head of this Department.

In response to interrogatory 6: None.

In response to interrogatory 7: I would suggest that some of the detailed reports printed by order of Congress, such as, for instance, Document 256, Fifty-eighth Congress, third session, "Expenditures in the Department of Agriculture," might be very well dispensed with. The publication referred to is expensive, and I am inclined to believe that of the 1,700 copies and over printed none is ever put to any practical use. It may also be very well worth while to consider whether the time has not arrived to do away entirely with the purely gratuitous distribution of public documents. The fact that every year the Superintendent of Documents is selling more and more copies of public documents, amounting for the year 1904 to 47,800, of which number 31,860 were publications of this Department, and this in spite of the fact that the great proportion of the editions of all these publications was distributed gratuitously, suggests that the sale of Government publications could be greatly encouraged until in time only those—to speak of the publications of this Department—known as emergency circulars should be distributed gratuitously. The price asked should not in any case exceed the cost of paper, presswork, and binding, with a very slight percentage added perhaps for handling, and means should be adopted, in case this plan were favored, to spread as widely as possible information as to what publications are available. Such a plan would undoubtedly obviate the great source of expense inevitably attending gratuitous distribution, namely, waste.

I shall be pleased to furnish your honorable committee, in the pursuance of its important labors, any additional information or assistance in my power, and I have instructed Mr. Hill, the Department Editor and Chief of the Division of Publications, to hold himself in readiness to supply your committee with any information as to details of publications which I have not attempted to cover in this communication.

Very respectfully,

JAMES WILSON,
Secretary.

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THE DEMANDS OF EDUCATIONAL INSTITUTIONS.

In my last report reference was made to the increasing number of requests coming from educational institutions for the publications of this Department. In regard to this line of work it was stated in that report that "The demand being comparatively new and giving evidence of rapid growth, must be reckoned with in the disposal of our publications in the future." The demands of this character have far more than kept pace with the anticipations formed and expressed. It has always been held that under ordinary circumstances no distribution of our publications in bulk was contemplated by the law governing the printing and binding for the Executive Departments, and it has been our general practice to send but one copy of any publication to one person. However, the purpose of these demands from educational institutions seems so commendable, and the conditions calling for this distribution so exceptional and urgent, that as far as possible we have endeavored to comply with them. It is more than probable if these demands continue to multiply in the future as they have in the past that our effort to reduce the average editions of many of our publications may be arrested and we be eventually compelled to ask for some future additions to the printing funds, both to the regular printing fund and to that provided for Farmers' Bulletins. At the same time it must be admitted that this use of our publications affords a wide field for extending the usefulness of the Department, and is a gratifying tribute to the practical value of our publications.

ADDITIONAL YEARBOOKS FOR STUDENTS IN AGRICULTURE.

In this connection I desire to refer to a proposition made some time ago to Congress for printing an additional number of Yearbooks with the view to supplying every student in the agricultural and industrial colleges taking a course in agriculture. I would respectfully suggest, should this proposition be revived, that this disposal of Yearbooks be provided for in a general addition to the quota of Yearbooks provided for the use of the Department. As has been frequently stated heretofore, the allowance of 30,000 copies of this publication available for the use of the Department is far too small to satisfy even the demands of those persons whose gratuitous aid to several of our Bureaus in carrying on their work justly entitles them to receive directly from the Department a copy of this useful work. An increase of 20,000 copies in the number placed at your disposal would be found extremely serviceable for this purpose, and might be coupled with the provision that students in agriculture should each be supplied with a copy.

A SUGGESTION REGARDING THE PREPARATION OF MANUSCRIPT.

One of the difficulties which confront the Editor in the control of the publications of the Department is the growing frequency with which the publications of one Bureau intrench upon the field of another Bureau's work. Under your instructions, in all such cases matter of this kind is referred to the Chief of the Bureau whose work seems to be intrenched upon, in order that he may have an opportunity not

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only of knowing whatever may be published by the Department in reference to the work in which he is especially interested, but to give him a further opportunity, if he desires it, of suggesting modifications to the statements made and for consultation in regard thereto with his colleague. In a few cases it has been the practice of some of the chiefs to themselves submit the manuscript to the person whose work has been touched upon therein before turning it over to the Division of Publications. It is very much to be desired that this practice be adopted generally. It will not only relieve the Editor of some embarrassment, but greatly facilitate transmission of the work to the Printer, which transmission is now in the majority of such cases greatly delayed. It will also help to obviate some reediting in the proof, which it is our earnest effort to avoid.

RECOMMENDATIONS.

A careful perusal of this report will show incontestably that the work has entirely outgrown the Division organization. This growth has not been through any attempt on the part of its Chief to enlarge the sphere of his work or aggrandize his position. A constant effort has been rather to restrict and keep the work within bounds, but it is obvious from the nature of the work that its growth and development must inevitably be beyond the control of the Chief, depending, as it does, entirely on the growth and development of the Department at large. There is to-day no branch of the Department work, whether Bureau, Office, or Division, which, in proportion to the sum of its expenditures and the number of its employees, has so small a number of employees of the higher grades to share the responsibility of the Chief and to assist him in the work as has the Division of Publications. Each one of the subdivisions of the work—the editorial, the illustration, the document, and now the indexing section—should be recognized in the light of the number of persons employed and the amount of work done, or in reference to its importance, each being properly charged with the work and responsibility attaching to an independent division. The total number of employees is about 160, and the total expenditures under the supervision of the Chief exceed $400,000, exclusive of the special appropriations expended by the Public Printer under the order of Congress for the printing of the Yearbook, and other reports and documents for the editing of which this Division is responsible.

In the estimates for the ensuing fiscal year I have, therefore, proposed a Bureau organization, the Editor and Chief to be Chief of Bureau, for one Editor who shall be Assistant Chief, and four Divisions—the Editorial Division, the Indexing Division, the Division of Illustrations, and the Document Division.

The increases asked for in the appropriations for the ensuing fiscal year are comparatively insignificant, aggregating barely 3 per cent of this year's appropriation, exclusive of the printing fund. Judging of the future by the past, it is quite evident that the Division will have to maintain its reputation as a Bureau in the accomplishment of a considerable increase in work at a very trifling increase in expenditure. The systematic arrangement of our work, which is conducted on thoroughly business principles, the increase, efficiency, and devotion to duty of the great bulk of the force, inspire me with the greatest confidence that this result can be attained.

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STATISTICS OF PUBLICATION WORK.

The details of the publication work of the Department are given in the following tables:

Number and classes of publications issued during the fiscal year 1905.

Publications—	
Chargeable to regular printing fund	518
Chargeable to divisional funds	12
Chargeable to Farmers' Bulletin fund	387
Printed as executive documents	70
Edited at Weather Bureau	85
Total	1,072

Number of publications, original and reprint, and number of pages and copies of each class, fiscal years 1902, 1903, 1904, and 1905.

Character of publication.	1902.			1903.		
	Number of publications.	Pages.	Copies.	Number of publications.	Pages.	Copies.
Original	355	18,184	4,009,136	375	21,262	4,583,225
Reprint	317	12,454	5,791,040	482	21,912	6,295,000
Weather Bureau	85	664	786,404	81	1,831	820,339
Total	757	31,302	10,586,580	938	45,005	11,698,564

Character of publication.	1904.			1905.		
	Number of publications.	Pages.	Copies.	Number of publications.	Pages.	Copies.
Original	379	21,647	5,470,286	391	18,988	5,838,672
Reprint	514	15,018	6,111,300	596	24,825	5,758,000
Weather Bureau	79	1,241	839,850	85	1,514	878,485
Total	972	37,906	12,421,386	1,072	45,327	12,475,157

Number of publications issued during ten years, 1896 to 1905, inclusive.

Year.	Number of publications.	Total number of copies.	Year.	Number of publications.	Total number of copies.
1896	376	6,561,700	1902	757	10,586,580
1897	424	6,541,210	1903	938	11,698,564
1898	501	6,280,365	1904	972	12,421,386
1899	603	7,075,975	1905	1,065	12,342,907
1900	488	7,152,428			
1901	606	7,899,281	Total	6,710	88,560,396

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Number of publications, original and reprint, and pages, by Bureaus, Divisions, and Offices, fiscal year 1905.

Bureaus, Divisions, and Offices.	Publications.			Pages.			Number of copies.		
	Original.	Reprint.	Total.	Original.	Reprint.	Total.	Original.	Reprint.	Total.
Secretary's Office	6	3	9	188	44	232	90,350	26,500	116,850
Executive documents	68	2	70	6,034	513	6,547	891,300	10,000	901,300
Accounts and disbursements	1		1	11		11	300		300
Animal Industry	54	131	185	1,724	4,323	6,047	160,236	1,404,750	1,564,986
Biological Survey	15	25	40	507	964	1,471	78,000	82,500	160,500
Chemistry	22	31	53	923	2,210	3,133	76,586	74,400	150,986
Entomology	25	39	64	703	1,043	1,746	124,950	291,200	416,150
Experiment Stations	59	184	243	3,895	9,074	12,969	302,400	1,788,050	2,090,450
Forestry	24	17	41	1,083	807	1,890	439,500	161,000	600,500
Library	5		5	233		233	4,250		4,250
Plant Industry	44	124	168	2,020	4,048	6,068	492,700	1,534,000	2,026,700
Publications	29	17	46	306	784	1,090	1,741,000	220,500	1,961,500
Public-Road Inquiries	3	12	15	73	416	489	7,000	117,500	124,500
Soils	8	6	14	435	146	581	21,800	39,500	61,300
Statistics	25	5	30	788	453	1,241	1,403,800	8,100	1,411,900
Weather Bureau[a]	88		88	1,579		1,579	882,985		882,985
Total	476	596	1,072	20,502	24,825	45,327	6,717,157	5,758,000	12,475,157

[a] Edited at the Weather Bureau: Publications, 85; pages, 1,514; copies, 878,485.

Amount expended for the various Bureaus, Divisions, and Offices for printing and binding, 1905.

Division of Accounts and Disbursements	$2,884.44
Bureau of Animal Industry	16,133.63
Division of Biological Survey	3,631.62
Bureau of Chemistry	8,498.62
Bureau of Entomology	3,631.30
Office of Experiment Stations	24,707.76
Bureau of Forestry	8,255.80
Library	8,128.57
Bureau of Plant Industry	18,407.82
Division of Publications	4,952.40
Office of Public-Road Inquiries	389.97
Bureau of Soils	3,402.74
Bureau of Statistics	18,470.80
Miscellaneous	3,926.37
Printing at branch printing offices for the various Bureaus, Divisions, and Offices	31,464.90
Total	**156,886.74**

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Farmers' Bulletins issued, 1899–1905.

Originals and reprints of Farmers' Bulletins.	Number of bulletins.	Number of copies.
Fiscal year 1905:		
Originals	24	630,000
Reprints	363	5,295,500
Total	387	5,925,500
Fiscal year 1904:		
Originals	25	775,000
Reprints	390	5,660,000
Total	415	6,435,000
Fiscal year 1903:		
Originals	22	725,000
Reprints	301	5,877,000
Total	323	6,602,000
Fiscal year 1902:		
Originals	23	575,000
Reprints	236	5,575,000
Total	259	6,150,000
Fiscal year 1901:		
Originals	14	415,000
Reprints	157	2,930,000
Total	171	3,345,000
Fiscal year 1900:		
Originals	18	525,000
Reprints	90	1,835,000
Total	108	2,360,000
Fiscal year 1899:		
Originals	22	520,000
Reprints	154	1,917,000
Total	176	2,437,000

Cost of printing Farmers' Bulletins, 1900–1905.

	Number of bulletins.	Number of copies.	Cost.
Fiscal year 1905:			
Paid from Farmers' Bulletin fund	388	5,925,500	$103,802.53
Fiscal year 1904:			
Paid from Farmers' Bulletin fund	415	6,435,000	104,787.68
Fiscal year 1903:			
Paid from Farmers' Bulletin fund	323	6,602,000	95,534.18
Fiscal year 1902:			
Paid from Farmers' Bulletin fund	259	6,150,000	107,363.05
Fiscal year 1901:			
Paid from Farmers' Bulletin fund	171	3,345,000	51,796.68
Fiscal year 1900:			
Paid from Farmers' Bulletin fund	97	2,150,000	30,665.15
Paid from general printing fund	11	210,000	3,469.69
Total	108	2,360,000	34,134.84

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New Farmers' Bulletins issued during the fiscal year 1905.

No. of bulletin.	Title of bulletin.	Total number of copies.
203	Canned Fruits, Preserves, and Jellies; Household Methods of Preparation	30,000
204	The Cultivation of Mushrooms	30,000
205	Pig Management	30,000
206	Milk Fever: Its Simple and Successful Treatment	20,000
207	Game Laws for 1904	30,000
208	Varieties of Fruits Recommended for Planting	30,000
209	Controlling the Boll Weevil in Cotton Seed and at Ginneries	15,000
210	Experiment Station Work—XXVII	30,000
211	The Use of Paris Green in Controlling the Cotton Boll Weevil	30,000
212	The Cotton Bollworm: Some Observations and Results of Field Experiments in 1904	50,000
213	Raspberries	30,000
214	Beneficial Bacteria for Leguminous Crops	30,000
215	Alfalfa Growing	30,000
216	The Control of the Boll Weevil, Including Results of Recent Investigations	15,000
217	Essential Steps in Securing an Early Crop of Cotton	25,000
218	The School Garden	50,000
219	Lessons from the Grain Rust Epidemic of 1904	20,000
220	Tomatoes	30,000
221	Fungous Diseases of the Cranberry	20,000
222	Experiment Station Work—XXVIII	20,000
223	Miscellaneous Cotton Insects in Texas	15,000
224	Canadian Field Pea	10,000
225	Experiment Station Work—XXIX	30,000
226	The Relation of Coyotes to Stock Raising in the West	10,000
	Total	630,000

Farmers' Bulletins contributed by Bureaus, Divisions, and Offices, 1905.

Bureaus, divisions, and offices.	New.	Reprints.	Number of copies.
Secretary's Office		1	10,000
Bureau of Animal Industry	2	77	1,375,000
Division of Biological Survey	2	4	90,000
Bureau of Chemistry		4	45,000
Division of Entomology	4	19	290,000
Office of Experiment Stations	4	125	1,855,500
Bureau of Forestry		5	90,000
Bureau of Plant Industry	12	102	1,820,000
Division of Publications		15	215,000
Office of Public Road Inquiries		7	105,000
Bureau of Soils		3	30,000
Total	24	363	5,925,500

Number of copies of Farmers' Bulletins issued (Nos. 1 to 226) and number distributed to members of Congress, 1894–1905.

Date.	Total number of copies issued.	Congressional distribution.	Date.	Total number of copies issued.	Congressional distribution.
Prior to 1894	540,000		In 1901	3,345,000	2,195,010
In 1894	278,500		In 1902	6,150,000	4,289,126
In 1895	1,567,000	885,770	In 1903	6,602,000	3,954,976
In 1896	1,891,000	1,316,695	In 1904	6,435,000	4,895,556
In 1897	2,387,000	1,967,237	In 1905	5,925,500	4,782,643
In 1898	2,170,000	1,580,065			
In 1899	2,437,000	1,101,985	Total	42,088,000	
In 1900	2,360,000	1,666,909			

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New Farmers' Bulletins issued each year from 1895 to 1905, inclusive.

Year.	Number of bulletins.	Year.	Number of bulletins.
In 1895	11	In 1902	23
In 1896	13	In 1903	22
In 1897	16	In 1904	25
In 1898	21	In 1905	24
In 1899	22		
In 1900	18	Total	209
In 1901	14		

Appropriations for the fiscal years 1903–1906.

Appropriation.	1903.	1904.	1905.	1906.
Statutory roll	$28,880	$29,380	$30,640	$114,370
General printing fund	[a] 155,000	[b] 160,000	[b] 160,000	[a] 160,000
Preparation, printing, and distribution of Farmers' Bulletins	107,500	105,000	105,000	96,750
Additional assistants, artists, draftsmen, etc	12,500	10,000	15,000	3,500
Labor, material, wagons, horses, rent of building, etc	[c] 84,000	85,000	90,000	30,000
Total	387,880	389,380	400,640	406,620

[a] Exclusive of $20,000 for Weather Bureau.
[b] Exclusive of $25,000 for Weather Bureau.
[c] Including a deficiency of $4,000.

Expenditures under general appropriations for fiscal year ended June 30, 1905.

General printing fund	$156,886.74
Preparation and printing of Farmers' Bulletins	103,802.53
Additional assistants, artists, draftsmen, etc	14,754.53
Labor, material, etc	89,596.04
Total	365,039.84

Expenditures for printing and binding, total and by funds, 1904.

TOTAL EXPENDITURES.

Divisional publications paid from general fund	$95,379.17
Divisional publications paid from special funds	5,401.58
Blank books, blank forms, etc., paid from general fund	30,042.67
Blank forms, etc., paid from special funds	4,482.24
Branch office (all work) paid from general fund	31,464.90
Farmers' Bulletins paid from Farmers' Bulletin fund	91,401.55
Total	258,172.11

EXPENDITURES BY FUNDS.

General printing fund ($160,000, exclusive of $25,000 for Weather Bureau):		
Expended for the various bureaus, divisions, and offices	$125,421.84	
Expended for printing at branch office for the various bureaus, divisions, and offices	31,464.90	
		$156,886.74
Farmers' Bulletin fund		91,401.55
Divisional funds:		
Bureau of Animal Industry		500.29
Office of Experiment Stations		1,745.07
Bureau of Forestry		6,614.23
Bureau of Statistics		1,024.23
Total		258,172.11

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Expenditures from the special funds of the Division.

Expenditures from the special appropriation of this division, $15,000, for additional assistants, pay of artists and draftsmen, artists' supplies, etc.:	
Illustrating, including pay of artists	$8,621.51
Artists' and photographic supplies	1,453.21
Pay of additional assistants, purchase of manuscripts, etc	4,679.81
Total	14,754.53
From fund, $90,000, for labor and material in the distribution of documents, etc.:	
Labor in distribution of documents	71,746.47
Materials, electric lights, etc	13,495.78
Rent for buildings for storage and distribution of documents	4,353.79
Total	89,596.04
From fund for preparation and printing Farmers' Bulletins:	
Preparation of Farmers' Bulletins	12,400.98
Printing Farmers' Bulletins	91,401.55
Total	103,802.53
Grand total	208,153.10

Requisitions on the branch printing office by Bureaus, Divisions, Offices, etc., 1905.

Secretary's Office	3
Division of Accounts and Disbursements	67
Bureau of Animal Industry	362
Division of Biological Survey	100
Bureau of Chemistry	229
Bureau of Entomology	214
Office of Experiment Stations	347
Bureau of Forestry	269
Library	72
Bureau of Plant Industry	965
Division of Publications	240
Office of Public Road Inquiries	50
Bureau of Soils	52
Bureau of Statistics	375
Miscellaneous	309
Total	3,654

Publications printed in the branch printing office, 1905.

Bureaus, Divisions, and Offices.	Requisitions.	Number of copies printed.
Secretary's Office	2	39,100
Bureau of Animal Industry	19	42,500
Division of Biological Survey	7	9,500
Bureau of Chemistry	6	21,050
Bureau of Entomology	21	87,000
Office of Experiment Stations	11	31,500
Bureau of Forestry	5	41,000
Bureau of Plant Industry	6	14,500
Division of Publications	27	1,871,500
Bureau of Soils	1	4,000
Total	105	2,161,600

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Total work done in the branch printing office, 1905.

Envelopes	2,291,754
Letter heads and note heads	1,313,545
Cards	3,377,544
Circulars	644,822
Blanks	5,939,906
Labels and shipping tags	1,227,845
Franks	1,234,410
Monthly and other lists	1,672,780
Crop Reporter (reprint)	300
Circular letters and other notices	615,350
Miscellaneous	2,069,547
Total	20,387,803
Number of requisitions, 1905	3,654
Number of requisitions, 1904	3,446
Number of pieces of work, 1904	17,285,233

The composition of 12 editions of the Crop Reporter, 8 quarto pages each, was done in the branch printing office.

Requisitions on the main printing office, by Bureaus, Divisions, and Offices.

Secretary's Office	5
Division of Accounts and Disbursements	88
Bureau of Animal Industry	244
Division of Biological Survey	51
Bureau of Chemistry	88
Bureau of Entomology	59
Office of Experiment Stations	300
Bureau of Forestry	114
Library	56
Bureau of Plant Industry	309
Division of Publications	59
Office of Public Road Inquiries	27
Bureau of Soils	35
Bureau of Statistics	39
Miscellaneous	11
Total	1,485

Illustration work, 1905.

Drawings made	1,015
Requests for duplicate electrotypes	198
Duplicate electrotypes furnished to correspondents on request	1,976
Requisitions and authorizations	107
Illustrations printed or published (not including reprints)	1,684
Negatives made	1,183
Plates and films developed	1,242
Velox and albuma prints	12,112
Bromide prints and enlargements	207
Silver prints	106
Prints mounted	1,143
Lantern slides	1,598
Blueprints	713
Large transparencies (for exposition)	73
Artists' salaries	$8,501.41
Artist and photographic supplies	1,453.21

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Number of publications sold by the Superintendent of Documents and amount received, 1900–1905.

Department.	Copies of publications sold.					
	1905.	1904.	1903.	1902.	1901.	1900.
Department of Agriculture.	38,124	31,860	30,038	25,279	24,127	16,905
All other Departments	29,876	15,940	11,048	9,932	9,458	10,998
Total	68,000	47,800	41,086	35,211	33,585	27,903

Department.	Amount received.					
	1905.	1904.	1903.	1902.	1901.	1900.
Department of Agriculture.	$4,836.85	$4,309.60	$4,200.35	$3,551.91	$3,220.25	$2,157.65
All other Departments	12,163.15	8,296.57	7,435.69	7,394.30	6,862.44	6,744.56
Total	17,000.00	12,606.17	11,636.04	10,946.21	10,082.69	8,902.21

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APPENDIX A.

PUBLICATIONS ISSUED DURING THE YEAR ENDED JUNE 30, 1905.

[The following publications were issued during the year ended June 30, 1905. Those to which a price is attached, with the exception of publications of the Weather Bureau, must be obtained of the Superintendent of Documents, Government Printing Office, Washington, D. C., to whom are turned over all copies not needed for official use, in compliance with section 67 of the act providing for the public printing and binding and the distribution of public documents. Remittances should be made to him by postal money order. Weather Bureau publications to which a price is attached must be obtained from the Chief of that Bureau. Applications for those that are for free distribution should be made to the Secretary of Agriculture, Washington, D. C.]

OFFICE OF THE SECRETARY.

	Copies.
Report of the Secretary of Agriculture. 1904. Pp. 99. Report No. 79. December 7, 1904	50,000
Adulteration of Alfalfa Seed. Pp. 2. Circular No. 12. January 3, 1905. Reprint, February 12, 1905	32,000 15,000
Report of the Appointment Clerk for 1904. By J. B. Bennett. Pp. iii, 315–337, I–XVII. (From Annual Reports, Department of Agriculture, 1904.) January 28, 1905	500
Standards of Purity for Food Products. (Superseding Circular No. 10.) Supplemental Proclamation. Pp. 14. Circular No. 13, Office of the Secretary. February 6, 1905	7,100
Report on New Department Buildings for 1904. By B. T. Galloway, Chairman Building Committee. Pp. ii, 525–529. (From Annual Reports, Department of Agriculture, 1904.) February 13, 1905	250
Methods and Benefits of Growing Sugar Beets. By Chas. F. Saylor, Special Agent for the Investigation of the Sugar Industry. Pp. 27. Circular No. 11. Reprint, May 6, 1905	1,500
Agricultural Development in Argentina. By Frank W. Bicknell, Special Agent and Agricultural Explorer. Pp. iii, 271–285, pls. 4. (From Yearbook of Department of Agriculture for 1904.) June 24, 1905	500
Sewage Disposal on the Farm, and the Protection of Drinking Water. By Theobald Smith, M. D., Professor in Harvard University, Pathologist to the Massachusetts State Board of Health, etc. Pp. 20, figs. 8. Farmers' Bulletin No. 43. Reprint, May 28, 1905	10,000

CONGRESSIONAL.

Report of Irrigation Investigations in Utah, under the direction of Elwood Mead, Chief of Irrigation Investigations, assisted by R. P. Teele, A. P. Stover, A. F. Doremus, J. D. Stannard, Frank Adams, and G. L. Swendsen. Pp. 330, pls. 19, figs. 2. Bulletin No. 124, Office of Experiment Stations. Congressional reprint, July 21, 1904	4,000
Progress of the Beet Sugar Industry in the United States in 1903. Pp. 184. Reprint, August 27, 1904	6,000
Advance Sheets[a]—Field Operations of the Bureau of Soils, 1903:	
Soil Survey of the Lufkin Area, Texas. By W. Edward Hearn and Party. Pp. 14, fig. 1, map. September 30, 1904	4,000
Soil Survey of Miller County, Ark. By J. O. Martin and E. P. Carr. Pp. 18, fig. 1, map. October 1, 1904	4,000

[a] These Advance Sheets were issued in editions ranging from 4,000 to 10,000, of which the Department in each case received for distribution 1,000 copies, the remainder being apportioned to Senators and Representatives in Congress.

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Advance Sheets—Field Operations Bureau of Soils, 1903—Continued. Copies.

Soil Survey of the Russell Area, Kansas. By A. W. Mangum and J. A. Drake. Pp. 20, fig. 1, map. October 10, 1904 4,000

Soil Survey of the New Orleans Area, Louisiana. By Thomas D. Rice and Lewis Griswold. Pp. 25, fig. 1, map. October 13, 1904 6,000

Soil Survey of Mason County, Ky. By R. T. Avon Burke. Pp. 19, fig. 1, map. October 15, 1904 4,000

Soil Survey of the Jacksonville Area, Texas. By W. Edward Hearn and James L. Burgess. Pp. 15, fig. 1, map. October 18, 1904 4,000

Soil Survey of the Woodville Area, Texas. By J. E. Lapham and Party. Pp. 15, fig. 1, map. October 18, 1904 4,000

Soil Survey of the Dover Area, Delaware. By F. E. Bonsteel and O. L. Ayrs. Pp. 26, fig. 1, map. October 20, 1904 4,000

Soil Survey of Davidson County, Tenn. By William G. Smith and Hugh H. Bennett. Pp. 17, fig. 1, map. October 25, 1904 4,000

Soil Survey of the Campobello Area, South Carolina. By A. W. Mangum and Aldert S. Root. Pp. 21, fig. 1, map. October 25, 1904 4,000

Soil Survey of the Nacogdoches Area, Texas. By W. Edward Hearn and James L. Burgess. Pp. 17, fig. 1, map. October 26, 1904 4,000

Soil Survey of the Fargo Area, North Dakota. By Thomas A. Caine. Pp. 29, fig. 1, map. November 5, 1904 4,000

Soil Survey of the Lockhaven Area, Pennsylvania. By J. O. Martin. Pp. 18, fig. 1, map. November 7, 1904 4,000

Soil Survey of McLean County, Illinois. By George N. Coffey, C. W. Ely, and Charles J. Mann, assisted by R. C. Lloyd, Clifford Willis, A. F. Kidder, G. A. Crosthwaite, and G. H. Eidman, of the Illinois Experiment Station. Pp. 25, fig. 1, map. November 10, 1904 4,000

Soil Survey of the Ashtabula Area, Ohio. By J. O. Martin and E. P. Carr. Pp. 16, fig. 1, map. November 19, 1904 4,000

Soil Survey of Worcester County, Maryland. By F. E. Bonsteel and William T. Carter, Jr. Pp. 29, fig. 1, map. November 19, 1904 4,000

Soil Survey of the Syracuse Area, New York. By F. E. Bonsteel, William T. Carter, Jr., and O. L. Ayrs. Pp. 31, fig. 1, map. November 26, 1904 8,000

Soil Survey of the Norfolk Area, Virginia. By J. E. Lapham. Pp. 31, fig. 1, map. November 26, 1904 4,000

Soil Survey of the Connecticut Valley. By Elmer O. Fippin. Pp. 27, fig. 1, map 1. November 28, 1904 9,000

Soil survey of the Brookings Area, South Dakota. By Frank Bennett, Jr. Pp. 19, fig. 1, map. December 2, 1904 4,000

Soil Survey of the Pontiac Area, Michigan. By Henry J. Wilder and W. J. Geib. Pp. 31, fig. 1, map. December 13, 1904 4,000

Soil Survey of Johnson County, Illinois. By George N. Coffey and C. W. Ely, assisted by R. C. Lloyd, Clifford Willis, A. F. Kidder, and G. A. Crosthwaite, of the Illinois Agricultural Experiment Station. Pp. 20, fig. 1, map. December 17, 1904 4,000

Soil Survey of the Marshall Area, Minnesota. By Henry J. Wilder. Pp. 21, fig. 1, map. December 17, 1904 4,000

Soil Survey of Sangamon County, Illinois. By George N. Coffey and C. W. Ely, assisted by J. G. Mosier and A. F. Kidder, of the Illinois Experiment Station. Pp. 21, fig. 1, map. December 20, 1904 4,000

Soil Survey of the San Jose Area, California. By Macy H. Lapham. Pp. 37, fig. 1, map. December 23, 1904 6,000

Soil Survey of Madison County, Indiana. By R. T. Avon Burke and La Mott Ruhlen. Pp. 19, fig. 1, map. December 27, 1904 4,000

Soil Survey of the Asheville Area, North Carolina. By J. E. Lapham and F. N. Meeker. Pp. 23, fig. 1, map. December 29, 1904 6,000

Soil Survey of the Leesburg Area, Virginia. By William T. Carter, jr., and W. S. Lyman. Pp. 45, fig. 1, map. December 31, 1904 10,000

Soil Survey of the Parsons Area, Kansas. By J. A. Drake. Pp. 23, fig. 1, map. January 6, 1905 4,000

Soil Survey of the McNeil Area, Mississippi. By William G. Smith and William T. Carter, jr. Pp. 18, fig. 1, map. January 6, 1905 4,000

Soil Survey of the Fort Valley Area, Georgia. By William G. Smith and William T. Carter, jr. Pp. 18, fig. 1, map. January 6, 1905 4,000

Soil Survey of Gadsden County, Florida. By Elmer O. Fippin and Aldert S. Root. Pp. 27, fig. 1, map. January 7, 1905 4,000

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Advance Sheets—Field Operations Bureau of Soils, 1903—Continued. Copies.

Soil Survey of the Grand Island Area, Nebraska. By W. Edward Hearn and James L. Burgess. Pp. 23, fig. 1, map. January 9, 1905 ---------- 8,000

Soil Survey of Scott County, Kentucky. By R. T. Avon Burke. Pp. 16, fig. 1, map. January 9, 1905---------- 4,000

Soil Survey of Knox County, Illinois. By George N. Coffey, C. W. Ely, and C. J. Mann, assisted by J. G. Mosier, Clifford Willis, and A. F. Kidder, of the Illinois Experiment Station. Pp. 20, fig. 1, map. January 12, 1905---------- 4,000

Soil Survey of the Mobile Area, Alabama. By R. T. Avon Burke and Party. Pp. 15, fig. 1, map. January 13, 1905---------- 4,000

Soil Survey of Shelby County, Missouri. By R. T. Avon Burke and La Mott Ruhlen. Pp. 19, fig. 1, map. January 13, 1905---------- 4,000

Soil Survey of the Fort Payne Area, Alabama. By Grove B. Jones and M. E. Carr. Pp. 21, fig. 1, map. January 14, 1905---------- 4,000

Soil Survey of the Craven Area, North Carolina. By William G. Smith and Geo. N. Coffey. Pp. 30, fig. 1, map. January 14, 1905-- 6,000

Soil Survey of the Indio Area, California. By J. Garnett Holmes and Party. Pp. 18, fig. 1, maps 2. January 18, 1905---------- 4,000

Soil Survey of the Solomonsville Area, Arizona. By Macy H. Lapham and N. P. Neill. Pp. 30, fig. 1, map. January 24, 1905------- 3,000

Soil Survey of the Viroqua Area, Wisconsin. By William G. Smith. Pp. 20, fig. 1, map. January 26, 1905---------- 6,000

Soil Survey of the Stanton Area, Nebraska. By W. Edward Hearn. Pp. 20, fig. 1, map. January 27, 1905---------- 4,000

Soil Survey of Acadia Parish, Louisiana. By Thomas D. Rice and Lewis Griswold. Pp. 29, fig. 1, map. January 31, 1905---------- 4,000

Soil Survey of the Long Island Area, New York. By Jay A. Bonsteel and Party. Pp. 42, fig. 1, maps 2. January 31, 1905-------- 6,000

Soil Survey of the Imperial Area, California. (Extending the Survey of 1901.) By J. Garnett Holmes and Party. Pp. 34, fig. 1, map. February 20, 1905---------- 4,000

Soil Survey of the Huntsville Area, Alabama. By Frank Bennett, Jr., and A. M. Griffen. Pp. 24, fig. 1, map. February 27, 1905-------- 4,000

Soil Survey of the Jamestown Area, North Dakota. By Thomas A. Caine and A. E. Kocher. Pp. 26, fig. 1, map. February 27, 1905--- 6,000

Soil Survey of the Los Angeles Area, California. By Louis Mesmer. Pp. 48, fig. 1, maps 2. March 3, 1905---------- 6,000

Soil Survey of the Paris Area, Texas. By Thomas A. Caine and A. E. Kocher. Pp. 34, fig. 1, map. March 3, 1905---------- 4,000

Soil Survey of Ouachita Parish, Louisiana. By Thomas D. Rice. Pp. 24, fig. 1, map. March 9, 1905---------- 4,000

Soil Survey of Winnebago County, Illinois. By George N. Coffey, C. W. Ely, and C. J. Mann, assisted by J. G. Mosier, R. C. Lloyd, Clifford Willis, and A. F. Kidder, of the Illinois Experiment Station. Pp. 27, fig. 1, map. March 13, 1905---------- 4,000

Soil Survey of the Salem Area, Oregon. By Charles A. Jones. Pp. 16, fig. 1, map. March 17, 1905---------- 4,000

Soil Survey of the Pikeville Area, Tennessee. By Henry J. Wilder and W. J. Geib. Pp. 31, fig. 1, map. March 17, 1905---------- 6,000

Soil Survey of the Baker City Area, Oregon. By Charles A. Jensen and W. W. Mackie. Pp. 24, fig 1, maps 4. March 21, 1905-------- 4,000

Soil Survey of the Provo Area, Utah. By Alfred M. Sanchez. Pp. 34, pls. 2, fig. 1, maps 6. March 21, 1905---------- 4,000

Soil Survey of the San Luis Valley, Colorado. By J. Garnett Holmes. Pp. 25, fig. 1, maps 2. March 24, 1905---------- 4,000

Soil Survey of the Laramie Area, Wyoming. By N. P. Neill and Party. Pp. 31, fig. 1, maps 3. March 28, 1905---------- 4,000

Soil Survey of Cerro Gordo County, Iowa. By Herbert W. Marean and Grove B. Jones. Pp. 25, fig. 1, map. March 30, 1905-------- 4,000

Soil Survey of the Blackfoot Area, Idaho. By W. E. McLendon. Pp. 22, fig. 1, maps 2. March 30, 1905---------- 4,000

Twentieth Annual Report of the Bureau of Animal Industry for the Year 1903. Pp. 618, pls. 22. November 4, 1904. Price, 50 cents----- 30,000

Report of the Secretary of Agriculture for 1904. Preliminary. Pp. 115. November 30, 1904---------- 5,000

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Copies.

Special Report on Diseases of Cattle. By Doctors Pearson, Murray, Atkinson, Lowe, Harbaugh, Law, Dickson, Mohler, Trumbower, Salmon, Smith, and Stiles. Pp. 533, pls. 52, figs. 12. Revised edition. December 16, 1904. Price, 65 cents---------- 50,000

Field Operations of the Bureau of Soils, 1903. (Fifth Report.) By Milton Whitney, Chief. With Accompanying Papers by Assistants in Charge of Field Parties. Pp. 1310, pls. 3, figs. 61, maps 1 to 78 in separate portfolio. February 1, 1905. Price, cloth, $6.35; paper, $6.10 ---------- 10,500

Annual Reports of the Department of Agriculture for the Fiscal Year Ended June 30, 1904. Pp. 560. March 3, 1905---------- 6,000

Progress of the Beet-Sugar Industry in the United States in 1904. By Charles F. Saylor, Special Agent. Pp. 183, pls. 4, figs. 2. Report No. 80. May 5, 1905. Price, 10 cents---------- 12,000

Yearbook of the United States Department of Agriculture. 1904. Pp. 776, frontispiece, pls. 75, figs. 64. May 19, 1905. Price, 65 cents---------- 500,000

Expenditures in the Department of Agriculture. Letter from the Secretary of Agriculture presenting a detailed statement of the expenditures of the Department for the fiscal year ending June 30, 1904, including Supplemental Reports. Pp. 476. House Doc. No. 256, 58th Cong., 3d Sess. May 3, 1905---------- 1,850

Message from the President of the United States transmitting a Report by the Secretary of Agriculture Relating to the Operations of the Bureau of Animal Industry for the Year ended June 30, 1904. Pp. 110. House Doc. 206, 58th Cong., 3d Sess---------- 1,850

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Report of the Chief of the Division of Accounts and Disbursements for 1904. By F. L. Evans. Pp. iii, 307–314. (From Annual Reports of the Department, 1904.) January 25, 1905---------- 300

BUREAU OF ANIMAL INDUSTRY.

Injuries to Cattle from Swallowing Pointed Objects. By Theobald Smith, M. D., and Charles F. Dawson, M. D., D. V. S. Pp. 4. Circular No. 8. Reprint, August 2, 1904---------- 2,000

Factory Cheese and How it is Made. By G. Merry. Pp. 8. Circular No. 19. Reprint, August 2, 1904---------- 2,000

Scales of Points for Judging Cattle of Dairy Breeds. By Maj. Henry E. Alvord, Chief of the Dairy Division. Pp. 14. Circular No. 48. August 11, 1904---------- 3,500
Reprint, December 3, 1904---------- 1,000
Reprint, March 8, 1905---------- 2,000

United States and State Standards for Dairy Products, 1904. By Maj. Henry E. Alvord, Chief of Dairy Division. Pp. 2. Circular No. 49. August 11, 1904---------- 2,000

A New Parasite (*Strongylus quadriradiatus* n. sp.) Found in the Pigeon. (Preliminary Report.) Pp. 6. Circular No. 47. August 13, 1904---------- 1,500

Treatment for Roundworms in Sheep, Goats, and Cattle. By Ch. Wardell Stiles, Ph. D., Zoologist, Bureau of Animal Industry. Pp. 8. Circular No. 35. Reprint, August 20, 1904---------- 2,000
Reprint, January 26, 1905---------- 1,000

The Fat Testing of Cream by the Babcock Method. By Ed. H. Webster, Inspector and Dairy Expert, Dairy Division, Bureau of Animal Industry, and C. E. Gray, Special Agent, Dairy Division, Bureau of Animal Industry. Pp. 29, pls. 2. Bulletin No. 58. Reprint, August 22, 1904. Price 5 cents---------- 5,000

The Farm Separator: Its Relation to the Creamery and to the Creamery Patron. By Ed. H. Webster, Inspector and Dairy Expert, Dairy Division, Bureau of Animal Industry. Pp. 47. Bulletin No. 59. Reprint, August 26, 1904. Price 5 cents---------- 5,000

Mycotic Stomatitis of Cattle. By Dr. John R. Mohler, Chief of the Pathological Division, Bureau of Animal Industry. Pp. 6. Circular No. 51. August 31, 1904---------- 5,000

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	Copies.
Information for Importers of Animals for Breeding Purposes. By George M. Rommel, B. S. A. Pp. 16. Circular No. 50. September 6, 1904	3,000
Reprint, April 5, 1905	1,000
The Relation of Bacteria to the Flavors of Cheddar Cheese. By Lore A. Rogers, Expert in Dairy Bacteriology, Bureau of Animal Industry. Pp. 38. Bulletin No. 62. September 16, 1904. Price 5 cents	5,500
Directions for the Use of Blackleg Vaccine. By Victor A. Nörgaard, Chief of Pathological Division, Bureau of Animal Industry. Pp. 8, figs. 3. Circular No. 23, second revision. Reprint, September 27, 1904	5,000
Influence of Formaldehyde on the Digestive Enzymes. By T. M. Price, Ph. D., Assistant in Biochemic Division, Bureau of Animal Industry. Pp. 8. Circular No. 59. October 5, 1904	500
Reprint, December 12, 1904	1,000
A Chemical Examination of Various Tubercle Bacilli. By E. A. De Schweinitz, Ph. D., M. D., Chief of Biochemic Division, Bureau of Animal Industry, and M. Dorset, M. D., Assistant Chief of Biochemic Division, Bureau of Animal Industry. Pp. 7. Circular No. 52. October 7, 1904	100
Reprint, December 1, 1904	1,000
The Government's Importation of Camels: A Historical Sketch. By Charles C. Carroll, A. M., Editorial Office, Bureau of Animal Industry. Pp. 18. Circular No. 53. October 7, 1904	200
Reprint, November 30, 1904	1,000
Invisible Microorganisms. By M. Dorset, M. D., Assistant Chief of Biochemic Division, Bureau of Animal Industry. Pp. 18. Circular No. 57. October 7, 1904	500
Reprint, December 12, 1904	1,000
Pulmonary Mycosis of Birds—With Report of a Case in a Flamingo. By John R. Mohler, A. M., V. M. D., Chief of Pathological Division, Bureau of Animal Industry, and John S. Buckley, D. V. S., Assistant in Pathological Division, Bureau of Animal Industry. Pp. 17. Circular No. 58, pls. 5. October 10, 1904	200
Reprint, January 11, 1905	1,000
The Desirability of Phosphates as an Addition to Culture Media for Tubercle Bacilli. By M. Dorset, M. D., Assistant Chief of Biochemic Division, Bureau of Animal Industry. Pp. 3, pls. 2. Circular No. 61. October 10, 1904	200
Reprint, January 18, 1905	1,000
Reindeer and Caribou. By C. C. Georgeson, M. S., Special Agent in Charge of Alaska Agricultural Experiment Stations, Office of Experiment Stations. Pp. 14, pls. 7. Circular No. 55. October 11, 1904	300
Reprint, January 6, 1905	1,000
Reprint, January 27, 1905	1,000
Certain Variations in the Morphology of Tubercle Bacilli of Bovine Origin. By C. N. McBryde, M. D., Assistant in Biochemic Division, Bureau of Animal Industry. Pp. 5, pls. 2. Circular No. 60. October 11, 1904	300
Reprint, January 7, 1905	1,000
Blackleg: Its Nature, Cause, and Prevention. By Victor A. Nörgaard, Chief of Pathological Division. Pp. 22; fig. 1. Circular No. 31, revised. October 12, 1904	5,000
Facts Concerning the History, Commerce, and Manufacture of Butter. By Harry Hayward, M. S., Assistant Chief of Dairy Division, Bureau of Animal Industry. Pp. 24. Circular No. 56. October 18, 1904	500
Reprint, April 22, 1905	5,000
Digestion Experiments with Poultry. By E. W. Brown, Ph. D., Assistant in the Biochemic Division. Prepared under the Supervision of E. A. De Schweinitz, Ph. D., Chief of Biochemic Division of the Bureau of Animal Industry. Pp. 112, pls. 4, charts 2. Bulletin No. 56. Reprint, October 20, 1904. Price, 20 cents	500
Reprint, March 11, 1905	200
State Stock Breeders' Associations. By George M. Rommel, B. S. A., Expert in Animal Husbandry, Bureau of Animal Industry. Pp. 53. Bulletin No. 64. October 29, 1904. Price, 5 cents	3,000

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Copies.

The Poultry and Egg Industry of Leading European Countries. By Andrew Fossum, Ph. D., Editorial Office, Bureau of Animal Industry. Pp. 79. Bulletin No. 65. November 11, 1904. Price, 5 cents..... 3,200

The Score Card in Stock Judging at Agricultural Colleges. By George M. Rommel, B. S. A., Expert in Animal Husbandry, Bureau of Animal Industry. Pp. 124, pls. 16, figs. 11. Bulletin No. 61. November 14, 1904. Price, 25 cents..... 1,000

A Plan for the Improvement of American Breeding Stock. By George M. Rommel, B. S. A., Expert in Animal Husbandry. Pp. 10. Circular No. 62. November 23, 1904..... 500
Reprint, March 8, 1905..... 1,000

A Review of Some Experimental Work in Pig Feeding. By George M. Rommel, B. S. A., Expert in Animal Husbandry, Bureau of Animal Industry. Pp. 51. Circular No. 63. December 6, 1904..... 3,000

Distribution and Magnitude of the Poultry and Egg Industry. By George Fayette Thompson, M. S., Editor, Bureau of Animal Industry. Pp. ii, 149–213. (From Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) Reprint, December 12, 1904..... 1,000

Manson's Eye Worm of Chickens (*Oxyspirura mansoni*). With a General Review of Nematodes Parasitic in the Eyes of Birds, and Notes on the Spiney-suckered Tapeworms of Chickens (*Davainea echinobothrida* (*Taenia botrioplites*) and *D. tetragona*). By B. H. Ransom, B. Sc., A. M., Scientific Assistant in Charge of the Zoological Laboratory, Bureau of Animal Industry. Pp. 72, pl. 1, figs. 52. Bulletin No. 60. December 19, 1904. Price, 20 cents..... 1,500

A New Nematode (*Gongylonema inglurvicola*) Parasitic in the Crop of Chickens. By Brayton H. Ransom, B. Sc., A. M., Zoologist. Pp. 3, figs. 2. Circular No. 64. December 16, 1904..... 1,500
Reprint, April 14, 1905..... 1,000

The American Saddle Horse. By Gen. John B. Castleman, Louisville, Ky. Pp. iii, 62–78, pls. 5. (From Nineteenth Annual Report of the Bureau of Animal Industry, 1902.) Reprint, December 19, 1904..... 1,000

Index Catalogue of Medical and Veterinary Zoology. (Authors: G to Gmelin.) By Ch. Wardell Stiles, Ph. D., Consulting Zoologist of Bureau of Animal Industry, Zoologist of U. S. Public Health and Marine-Hospital Service, and Albert Hassall, M. R. C. V. S., Veterinary Inspector, Bureau of Animal Industry. Pp. 511–572. Bulletin No. 39, Part 7. December 19, 1904. Price, 5 cents..... 2,000

Same. (Authors: Gobee to Geyser.) Pp. 573–659. Bulletin No. 39, Part 8. December 19, 1904. Price, 5 cents..... 2,000

Foot Rot of Sheep: Its Nature, Cause, and Treatment. By John R. Mohler, V. M. D., Chief of Pathological Division, Bureau of Animal Industry, and Henry W. Washburn, D. V. S., Acting Assistant Chief of Pathological Division, Bureau of Animal Industry. Pp. 39, pls. 3, fig. 1. Bulletin No. 63. December 22, 1904. Price, 10 cents..... 3,900
Reprint, June 30, 1905..... 2,000

Report of the Chief of the Bureau of Animal Industry for 1904. By D. E. Salmon. Pp. iii, 43–67. (From Annual Reports, Department of Agriculture, 1904.) January 7, 1905..... 200

Directions for the Pasteurization of Milk. By D. E. Salmon, Chief of Bureau. Pp. 2. Circular No. 1, revised. Reprint, January 21, 1905. 1,000

The Gid Parasite (*Coenurus cerebralis*): Its Presence in American Sheep. By B. H. Ransom, B. Sc., A. M., Scientific Assistant in Charge of the Zoological Laboratory, Bureau of Animal Industry. Pp. 23, figs. 12. Bulletin No. 66. January 23, 1905. Price 5 cents... 3,500

Actinomycosis, or Lumpy Jaw. By D. E. Salmon, D. V. M., Chief of Bureau of Animal Industry. Pp. 5. Circular No. 7. Reprint, January 26, 1905..... 1,000

Texas Fever, or Southern Cattle Fever. By Drs. D. E. Salmon and Theobald Smith. Pp. 13. Circular No. 69. February 16, 1905..... 2,000
Reprint, June 22, 1905..... 1,500

Ophthalmia in Cattle. By M. R. Trumbower, D. V. S. (Revised in 1904 by Leonard Pearson, B. S., V. M. D.) Pp. 2. Circular No. 65. February 17, 1905..... 2,000
Reprint, June 1, 1905..... 1,000

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	Copies.
Tuberculosis of Cattle. By Drs. D. E. Salmon and Theobald Smith. (Revised in 1904 by Doctors Salmon and Mohler.) Pp. 28. Circular No. 70. February 17, 1905	2,000
Reprint, June 23, 1905	1,500
Osteomalacia, or Creeps in Cattle. By V. T. Atkinson, V. S. (Revised in 1904 by John R. Mohler, V. M. D.) Pp. 2. Circular No. 66. February 17, 1905	2,000
Reprint, June 1, 1905	1,500
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Methods for the Detection of Renovated Butter. (Cooperative Work, Association of Official Agricultural Chemists, 1904.) By G. E. Patrick, Referee on Dairy Products, A. O. A. C., Chief, Dairy Laboratory. Pp. 3. Circular No. 19. August 18, 1904 350

Proceedings of the Twentieth Annual Convention of the Association of Official Agricultural Chemists Held at Washington, D. C., November 19, 20, and 21, 1903. Edited by Harvey W. Wiley, Secretary of the Association. Pp. 252. Bulletin No. 81. Reprint, August 19, 1904. Price, 15 cents 1,000

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The Chemical Composition of Apples and Cider. I. The Composition of Apples in Relation to Cider and Vinegar Production. II. The Composition of Cider as Determined by Dominant Fermentation with Pure Yeasts. By Wm. B. Alwood, Special Agent, U. S. Department of Agriculture, and Mycologist of the Virginia Agricultural Experiment

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Station; R. J. Davidson, Special Agent, U. S. Department of Agriculture, and Chemist of the Virginia Agricultural Experiment Station; and W. A. P. Moncure, Assistant Mycologist, Virginia Agricultural Experiment Station. Pp. 46. Bulletin No. 88. November 29, 1904. Price, 5 cents 4,000
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Description of a New Respiration Calorimeter and Experiments on the Conservation of Energy in the Human Body. By W. O. Atwater, Ph. D., Professor of Chemistry, Wesleyan University, and E. B. Rosa, Ph. D., Professor of Physics, Wesleyan University. Pp. 94, pls. 8, figs. 12. Bulletin No. 63. Reprint, January 12, 1905. Price, 10 cents 300

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Development of the Text-Book of Agriculture in North America. By L. H. Bailey, Director of the College of Agriculture and Agricultural Experiment Station of Cornell University. Pp. 689–712. (From Annual Report of the Office of Experiment Stations for year ended June 30, 1903. Reprint, March 24, 1905 500

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Dietary Studies with Harvard University Students. By Edward Mallinckrodt, jr. Pp. 63. Bulletin No. 152. April 15, 1905. Price, 5 cents---------- 3,200

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Experiments on Losses in Cooking Meat, 1898–1900. By H. S. Grindley, D. Sc., Associate Professor of Chemistry, College of Science, University of Illinois, with the Cooperation of H. McCormack, M. S., and H. C. Porter, M. S. Pp. 64. Bulletin No. 102. Reprint, April 24, 1905. Price, 5 cents---------- 500

Studies on Bread and Bread Making at the University of Minnesota in 1899 and 1900. By Harry Snyder, B. S., Professor of Chemistry, College of Agriculture, University of Minnesota, and Chemist, Agricultural Experiment Station. Pp. 65, pls. 3, fig. 1. Bulletin No. 101. Reprint, April 25, 1905. Price, 10 cents---------- 500

The Cotton Plant: Its History, Botany, Chemistry, Culture, Enemies, and Uses. Prepared under the Supervision of A. C. True, Ph. D., Director. With an Introduction by Charles W. Dabney, jr., Ph. D., Assistant Secretary of Agriculture. Pp. 433, pls. 4, figs. 32. Bulletin No. 33. Reprint, May 4, 1905. Price, 35 cents---------- 500

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Proceedings of the Ninth Annual Meeting of the American Association of Farmers' Institute Workers, Held at St. Louis, Mo., October 18–20, 1904. Edited by W. H. Beal and John Hamilton, for the Office of Experiment Stations, and G. C. Creelman, for the Association. Pp. 91. Bulletin No. 154. June 19, 1905. Price, 5 cents---------- 5,000

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Irrigation in Field and Garden. By E. J. Wickson, M. A., Professor of Agricultural Practice, University of California, and Horticulturist of the California Agricultural Experiment Station. Pp. 40, figs. 18. Farmers' Bulletin No. 138. Reprint, April 7, 1905	15,000

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Irrigation in Fruit Growing. By E. J. Wickson, M. A., Professor of Agricultural Practice, University of California, and Horticulturist of the California Experiment Station. Pp. 48, figs. 8. Farmers' Bulletin No. 116. Reprint, June 10, 1905---- 5,000

Kafir Corn: Characteristics, Culture, and Uses. By C. C. Georgeson, Professor of Agriculture in Kansas State Agricultural College. Pp. 16, fig. 1. Farmers' Bulletin No. 37. Reprint, June 8, 1905---- 10,000

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Forest Resources of Texas. By William L. Bray, Collaborator, Bureau of Forestry. Pp. 71, pls. 8, figs. 2, maps 3. Bulletin No. 47. July 22, 1904. Price, 15 cents---- 10,000

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The Timber of the Edwards Plateau of Texas: Its Relation to Climate, Water Supply, and Soil. By William L. Bray, Collaborator, Bureau of Forestry. Pp. 30, frontispiece, pls. 5. Bulletin No. 49. July 29, 1904. Price, 10 cents---- 10,000

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The Soy Bean as a Forage Crop. By Thomas A. Williams, Assistant Agrostologist. Prepared under the direction of the Agrostologist. With an Appendix on Soy Beans as Food for Man. By C. F. Langworthy, Ph. D., Office of Experiment Stations. Pp. 24, figs. 5. Farmers' Bulletin No. 58, revised. Reprint, April 10, 1905---------- 10,000

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Canada Thistle. (*Carduus arvensis* (L.) Robs.) By Lyster H. Dewey, Assistant Botanist. Pp. 14, figs. 4. Circular No. 27, revised. Reprint, September 8, 1904	3,000
The Chayote: A Tropical Vegetable. By O. F. Cook, Special Agent for Tropical Agriculture. Pp. 31, pls. 8. Bulletin No. 28. Reprint, March 9, 1905. Price, 10 cents	1,000
Weeds: And How to Kill Them. By Lyster H. Dewey, Assistant Botanist. Pp. 32, figs. 11. Farmers' Bulletin No. 28, revised edition. Reprint, August 4, 1904	20,000
Reprint, December 23, 1904	10,000
Second revision. Pp. 30, figs. 11. April 7, 1905	10,000
Reprint, June 14, 1905	10,000
Thirty Poisonous Plants of the United States. By V. K. Chesnut, Assistant Botanist, U. S. Department of Agriculture. Pp. 32, figs. 24. Farmers' Bulletin No. 86. Reprint, September 1, 1904	15,000
Reprint, April 15, 1905	10,000
The Farmer's Interest in Good Seed. By A. J. Pieters, in Charge of Pure-Seed Investigations, Division of Botany. Pp. 24, figs. 7. Farmers' Bulletin No. 111. Reprint, September 22, 1904	15,000
Reprint, March 31, 1905	10,000
Reprint, June 24, 1905	10,000
Rice Culture in the United States. By Dr. S. A. Knapp. Pp. 29. Farmers' Bulletin No. 110. Reprint, October 13, 1904	15,000

Pomology.

Revised Catalogue of Fruits Recommended for Cultivation in the Various Sections of the United States and the British Provinces by the American Pomological Society. Revised by a committee of the society. By W. H. Ragan. Pp. 63, pl. 1. Bulletin No. 8. Pomology. Reprint, December 30, 1904	2,000
Grape Growing in the South. By S. M. Tracy, M. S., Formerly Director of the Mississippi Agricultural Experiment Station. Pp. 32, figs. 6. Farmers' Bulletin No. 118. Reprint, September 16, 1904	10,000
Reprint, May 23, 1905	10,000
The Apple and How to Grow It. By G. B. Brackett, Pomologist, Bureau of Plant Industry. Pp. 32, figs. 10. Farmers' Bulletin No. 113, revised June, 1904. Reprint, October 3, 1904	20,000
Reprint, March 23, 1905	15,000
Reprint, April 22, 1905	15,000

Vegetable Physiology and Pathology.

Peach Growing for Market. By Erwin F. Smith, Division of Vegetable Physiology and Pathology. Pp. 24, figs. 21. Farmers' Bulletin No. 33. Reprint, October 4, 1904	15,000
Reprint, June 2, 1905	10,000
Spraying for Fruit Diseases. By B. T. Galloway, Chief of Division of Vegetable Physiology and Pathology. Pp. 13, figs. 6. Farmers' Bulletin No. 38. Reprint, October 11, 1904	10,000
Reprint, March 20, 1905	10,000
Reprint, May 15, 1905	10,000
The Black Rot of the Cabbage. By Erwin F. Smith, Division of Vegetable Physiology and Pathology. Pp. 22, fig. 1. Farmers' Bulletin No. 68. Reprint, October 22, 1904	10,000
Reprint, June 5, 1905	10,000
Potato Diseases and Their Treatment. By B. T. Galloway, Chief of the Division of Vegetable Physiology and Pathology. Pp. 12, figs. 4. Farmers' Bulletin No. 91. Reprint, August 19, 1904	15,000
Reprint, February 13, 1905	15,000
Reprint, April 20, 1905	15,000
The Grain Smuts: How They are Caused and How to Prevent Them. By Walter T. Swingle, Special Agent, Division of Vegetable Physiology and Pathology. Pp. 20. Farmers' Bulletin No. 75. Reprint, February 23, 1905	10,000

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DIVISION OF PUBLICATIONS.

	Copies.
Monthly List of Publications, June, 1904. Pp. 8	140,000
Monthly List of Publications, July, 1904. Pp. 4	140,000
Monthly List of Publications, August, 1904. Pp. 4	140,000
Monthly List of Publications, September, 1904. Pp. 4	140,000
Monthly List of Publications, October, 1904. Pp. 4	140,000
Monthly List of Publications, November, 1904. Pp. 4	140,000
Monthly List of Publications, December, 1904. Pp. 4	140,000
Monthly List of Publications, January, 1905. Pp. 4	144,500
Monthly List of Publications, February, 1905. Pp. 4	147,500
Monthly List of Publications, March, 1905. Pp. 4	149,500
Monthly List of Publications, April, 1905. Pp. 4	150,000
Monthly List of Publications, May, 1905. Pp. 4	150,000
Organization of Department of Agriculture, 1904–5. Pp. 27. Circular No. 1, revised to September 1, 1904	2,500
List of Bulletins and Circulars issued by the U. S. Department of Agriculture and Available for Free Distribution. Corrected to November 1, 1904. Pp. 36. No. 247. Twelfth edition. December 7, 1904	5,000
Reprint, February 20, 1905	5,000
Report of the Editor for 1904. By George Wm. Hill. Pp. iii, 339–404. (From Annual Reports, Department of Agriculture, 1904.) January 28, 1905	1,500
Index to the Yearbook of the U. S. Department of Agriculture, 1894–1900. Prepared by Charles H. Greathouse, an Assistant Editor, Division of Publications. Pp. 196. Bulletin No. 7. Reprint, February 7, 1905. Price 10 cents	500
Publications of the U. S. Department of Agriculture for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Pp. 63. No. 179, 12th edition. Corrected to February 1, 1905. March 13, 1905	10,000
State Publications on Agriculture. By Charles H. Greathouse, Division of Publications. Pp. ii, 521–526. (From Yearbook of Department of Agriculture for 1904.) June 14, 1905	500
Marketing Farm Produce. By George G. Hill, Formerly Manager and Editor of the American Farmer, Illinois. Pp. 32, figs. 7. Farmers' Bulletin No. 62. Reprint, August 3, 1904	15,000
Reprint, March 16, 1905	10,000
Reprint, April 25, 1905	10,000
Practical Suggestions for Farm Buildings. By George G. Hill. Pp. 48, figs 25. Farmers' Bulletin No. 126. Reprint, August 22, 1904	20,000
Reprint, April 7, 1905	20,000
Reprint, June 2, 1905	15,000
The Vegetable Garden. By Charles H. Greathouse, A. M., Division of Publications. Pp. 24, figs. 8. Farmers' Bulltin No. 94. Reprint August 29, 1904	20,000
Reprint, October 28, 1904	20,000
Reprint, April 28, 1905	15,000
Asparagus Culture. By R. B. Handy, Division of Publications. Pp. 40 figs. 17. Farmers' Bulletin No. 61. Reprint, September 6, 1904	10,000
Reprint, March 13, 1905	10,000
Reprint, June 21, 1905	10,000
Clearing New Land. By Franklin Williams, Jr., Farmer and Horticulturist, Fairfax County, Va. Pp. 24, figs. 7. Farmers' Bulletin No. 150. Reprint, October 28, 1904	15,000
Suggestions to Southern Farmers. Prepared in the Division of Publications. Pp. 48. Farmers' Bulletin No. 98. Reprint, September 23, 1904	15,000
Reprint, May 18, 1905	15,000

OFFICE OF PUBLIC ROAD INQUIRIES.

The Railroads and the Wagon Roads. Pp. 4. Circular No. 37. Reprint, November 3, 1904	5,000
Office of Road Inquiry. By Roy Stone, Director of Office of Road Inquiry. Object-Lesson Roads. By Roy Stone, Director of Office of	

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	Copies.
Road Inquiry. Pp. ii, 175–180, 373–382, pls. 2, fig. 1. (From Yearbook of Department of Agriculture for 1897.) Reprint, December 1, 1904	1,000
Repairs of Macadam Roads. By E. G. Harrison, C. E. Pp. 15. Circular No. 30. Reprint, December 7, 1904	2,000
Report of the Office of Public Road Inquiries for 1904. By Martin Dodge, Director. Pp. iii, 419–443. (From Annual Reports, Department of Agriculture, 1904.) January 27, 1905	1,000
Reprint, June 13, 1905	1,000
Use of Mineral Oil in Road Improvement. By James W. Abbott, Special Agent, Rocky Mountain and Pacific Coast Division, Office of Public Road Inquiries. Pp. iii, 439–450, pls. 3, figs. 4. (From Yearbook of Department of Agriculture for 1902.) Reprint, March 21, 1905	2,000
Proceedings of the North Carolina Good Roads Convention, Held at Raleigh, February 12 and 13, 1902. Compiled by J. A. Holmes, Special Agent, Southern Division. Pp. 72, pls. 5. Bulletin No. 24. Reprint, April 21, 1905. Price 10 cents	2,000
Practical Road Building in Madison County, Tennessee. By Sam C. Lancaster, Chief Engineer, Madison County Good Roads Commission. Pp. ii, 323–340, pls. 5, figs. 5. (From Yearbook of Department of Agriculture for 1904.) June 22, 1905	5,000
Earth Roads. By Maurice O. Eldridge, Assistant Director, Public Road Inquiries. Pp. 24, figs. 20. Farmers' Bulletin No. 136. Reprint, August 5, 1904	20,000
Reprint, March 20, 1905	15,000
Good Roads for Farmers. By Maurice O. Eldridge, Acting Director Office of Public Road Inquiries. Pp. 48, figs. 49. Farmers' Bulletin No. 95. Reprint, August 9, 1904	20,000
Reprint, November 12, 1904	10,000
Reprint, February 24, 1905	15,000
Reprint, April 15, 1905	15,000
Reprint, June 12, 1905	10,000

BUREAU OF SOILS.

The Work of the Bureau of Soils. Pp. 13. Circular No. 13. Reprint, October 7, 1904	4,000
Reprint, June 9, 1905. Revised	5,000
Investigations in Soil Fertility. By Milton Whitney and F. K. Cameron. Pp. 48, pls. 4, figs. 7. Bulletin No. 23. October 11, 1904. Price, 5 cents	2,500
The Centrifugal Method of Mechanical Soil Analysis. By Lyman J. Briggs, F. O. Martin, and I. R. Pearce. Pp. 38, pls. 2, figs. 7. Bulletin No. 24. November 22, 1904. Price, 10 cents	2,500
Opportunities for the Production of Cigar-Leaf Tobacco in East Texas and Alabama. Pp. 4. Circular No. 14. January 10, 1905	4,000
Contributions to Our Knowledge of the Aeration of Soils. By Edgar Buckingham. Pp. 52. Bulletin No. 25. January 12, 1905. Price, 5 cents	2,100
Report of the Chief of the Bureau of Soils for 1904. By Milton Whitney. (From Annual Reports, Department of Agriculture, 1904.) Pp. 241–269. January 27, 1905	200
Investigations in Soil Management. Part I. Amount of Plant Food Readily Recoverable from Field Soils with Distilled Water. Part II. Relation of Crop Yields to the Amounts of Water-Soluble Plant-Food Materials Recovered from Soils. Part III. Relation of Differences of Climatological Environment to Crop Yields. By Prof. F. H. King, Chief of the Division of Soil Management. Pp. 205, pls. 4, figs. 9. Bulletin No. 26. April 17, 1905. Price, 15 cents	1,000
Tobacco Soils of the United States: A Preliminary Report Upon the Soils of the Principal Tobacco Districts. By Milton Whitney, Chief of Division of Soils. Pp. 47, pls. 13. Bulletin No. 11. Reprint, May 17, 1905. Price, 10 cents	500
Experiments in Growing Cuban Seed Tobacco in Texas. By George T. McNess and Walter M. Hinson. Pp. 44. Bulletin No. 27. June 2, 1905. Price, 5 cents	6,000

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	Copies.
Manurial Requirements of the Leonardtown Loam Soils of St. Mary County, Md. By Frank D. Gardner, in Charge of Soil Management. Pp. 13. Circular No. 15. June 28, 1905	3,500
The Culture of Tobacco. By Otto Carl Butterweck. Pp. 23. Farmers' Bulletin No. 82. Reprint, April 11, 1905	10,000
Methods of Curing Tobacco. By Milton Whitney, Chief of Division of Soils. Pp. 24. Farmers' Bulletin No. 60, second revision. Reprint, April 13, 1905	10,000
Reprint, April 13, 1905	10,000

BUREAU OF STATISTICS.

Crop Reporter. Vol. 6, No. 3. July, 1904	100,000
Crop Reporter. Vol. 3, No. 12. April, 1902. Supplement	1,000
Crop Reporter. Vol. 6, No. 4. August, 1904	100,000
Crop Reporter. Vol. 6, No. 5. September, 1904	100,000
Crop Reporter. Vol. 6, No. 6. October, 1904	100,000
Crop Reporter. Vol. 6, No. 7. November, 1904	100,000
Crop Reporter. Vol. 6, No. 8. December, 1904	100,000
Crop Reporter. Vol. 6, No. 8. December, 1904. Supplement	100,000
Crop Reporter. Vol. 6, No. 9. January, 1905	105,000
Crop Reporter. Vol. 6, No. 10. February, 1905	100,000
Crop Reporter. Vol. 6, No. 11. March, 1905	105,000
Crop Reporter. Vol. 6, No. 12. April, 1905	105,000
Crop Reporter. Vol. 7, No. 1. May, 1905	105,000
Crop Reporter. Vol. 7, No. 2. June, 1905	105,000
Agricultural Exports of the United States, 1851–1902. By Frank H. Hitchcock. Pp. 100. Bulletin No. 34, Division of Foreign Markets. July 12, 1904. Price, 10 cents	6,000
The Commercial Cotton Crops of 1900–1901, 1901–1902, and 1902–1903. By James L. Watkins, of the Bureau of Statistics. Pp. 83. Bulletin No. 28, Bureau of Statistics. July 27, 1904. Price, 5 cents	25,000
Agricultural Imports of Germany, 1897–1901. By Frank H. Hitchcock. Pp. 323. Bulletin No. 30, Division of Foreign Markets. Reprint, August 16, 1904. Price, 20 cents	1,000
Methods and Routes for Exporting Farm Products. By Edward G. Ward, Jr., Expert in Transportation Statistics. Pp. 62. Bulletin No. 29. October 12, 1904. Price, 5 cents	4,600
Progress of Agriculture in the United States. By George K. Holmes, Assistant Statistician. Pp. iii, 307–334. (From Yearbook of Department of Agriculture for 1899.) Reprint, December 17, 1904	1,000
International Sugar Situation. Origin of the Sugar Problem and Its Present Aspects under the Brussels Convention. Pp. 98, pls. 4, fig. 1. Bulletin No. 30. December 21, 1904. Price, 10 cents	13,000
Practices in Crop Rotation. By George K. Holmes, of the Division of Statistics. Pp. ii, 519–532. (From Yearbook of Department of Agriculture for 1902.) Reprint, January 4, 1905	500
Report of the Statistician for 1904. By John Hyde. Pp. iii, 405–412. (From Annual Reports, Department of Agriculture, 1904.) January 28, 1905	1,000
Foreign Trade in Farm and Forest Products, 1904. By George K. Holmes, Chief of the Division of Foreign Markets. Pp. 19. Circular No. 16. March 1, 1905	4,300
Flaxseed Production, Commerce, and Manufacture in the United States. By Charles M. Daugherty, of the Division of Statistics. Pp. iii, 421–438. (From Yearbook of Department of Agriculture for 1902.) Reprint, March 8, 1905	1,000
Imports of Farm and Forest Products, 1901–1903, by Countries from which consigned. Compiled by the Division of Foreign Markets. Pp. 66. Bulletin No. 31. March 29, 1905. Price, 5 cents	4,000
Exports of Farm and Forest Products, 1901–1903, by Countries to which Consigned. Compiled by the Division of Foreign Markets. Pp. 100, Bulletin No. 32. April 14, 1905. Price, 5 cents	4,500
Trade with Noncontiguous Possessions in Farm and Forest Products, 1901–1903. Compiled by the Division of Foreign Markets. Pp. 40. Bulletin No. 33. May 9, 1905. Price, 5 cents	4,000

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	Copies.
The Castor Oil Industry. By Charles M. Daugherty, of the Bureau of Statistics. Pp. iii, 287–298. (From Yearbook of Department of Agriculture for 1904.) June 9, 1905	2,000
Consumers' Fancies. By George K. Holmes, Chief of Division of Foreign Markets, Bureau of Statistics. Pp. ii, 417–434. (From Yearbook of Department of Agriculture for 1904.) June 17, 1905	4,000
Statistical Matter Relating to Principal Crops and Farm Animals, Freight Rates, Exports, etc., of the United States, 1904. Pp. 625–742. (From Yearbook of Department of Agriculture for 1904.) June 22, 1905	10,000

WEATHER BUREAU.

Monthly Weather Review (a summary by months of weather conditions throughout the United States, based upon reports of nearly 3,000 regular and voluntary observers). Quarto. Price, 20 cents; $2 per year.

Vol. XXXII, No. 5. May, 1904. Pp. 207–254, figs. 3, charts 15	4,800
Vol. XXXII, No. 6. June, 1904. Pp. 255–301, figs. 5, charts 13	4,800
Vol. XXXII, No. 7. July, 1904. Pp. 303–352, figs. 2, charts 10	4,800
Vol. XXXII, No. 8. August, 1904. Pp. 353–400, figs. 4, charts 13	4,900
Vol. XXXII, No. 9. September, 1904. Pp. 401–444, pls. 2, charts 10	4,900
Vol. XXXII, No. 10. October, 1904. Pp. 445–496, figs. 11, charts 11	4,900
Vol. XXXII, No. 11. November, 1904. Pp. 497–546, figs. 6, charts 9	5,100
Vol. XXXII, No. 12. December, 1904. Pp. 547–592, figs. 2, charts 15	5,100
Vol. XXXII, No. 13. Annual Summary, 1904. Pp. xiii, 593–620, charts 13	5,100
Vol. XXXIII, No. 1. January, 1905. Pp. 40, charts 11	5,100
Vol. XXXIII, No. 2. February, 1905. Pp. 41–83, figs. 25, charts 11	5,100
Vol. XXXIII, No. 3. March, 1905. Pp. 85–125, figs. 3, charts 12	5,100
Vol. XXXIII, No. 4. April, 1905. Pp. 127–182, figs. 6, charts	5,100
Weather Crop Bulletin No. 16. July 4, 1904	4,500
Weather Crop Bulletin No. 17. July 11, 1904	4,475
Weather Crop Bulletin No. 18. July 18, 1904	4,475
Weather Crop Bulletin No. 19. July 25, 1904	4,475
Weather Crop Bulletin No. 20. August 1, 1904	4,475
Weather Crop Bulletin No. 21. August 8, 1904	4,475
Weather Crop Bulletin No. 22. August 15, 1904	4,475
Weather Crop Bulletin No. 23. August 22, 1904	4,850
Weather Crop Bulletin No. 24. August 29, 1904	4,525
Weather Crop Bulletin No. 25. September 5, 1904	4,525
Weather Crop Bulletin No. 26. September 12, 1904	4,525
Weather Crop Bulletin No. 27. September 19, 1904	4,525
Weather Crop Bulletin No. 28. September 26, 1904	4,525
Weather Crop Bulletin No. 29. October 3, 1904	4,525
Weather Crop Bulletin No. 30. October 10, 1904	4,525
Weather Crop Bulletin No. 31. November, 1904	5,500
Weather Crop Bulletin No. 32. December, 1904	5,500
Weather Crop Bulletin No. 1. January, 1905	4,900
Weather Crop Bulletin No. 2. February, 1905	4,900
Weather Crop Bulletin No. 3. March, 1905	4,900
Weather Crop Bulletin No. 4. April 10, 1905	4,600
Weather Crop Bulletin No. 5. April 17, 1905	5,575
Weather Crop Bulletin No. 6. April 24, 1905	4,575
Weather Crop Bulletin No. 7. May 1, 1905	5,100
Weather Crop Bulletin No. 8. May 8, 1905	4,575
Weather Crop Bulletin No. 9. May 15, 1905	4,575
Weather Crop Bulletin No. 10. May 22, 1905	4,575
Weather Crop Bulletin No. 11. May 29, 1905	4,575
Weather Crop Bulletin No. 12. June 5, 1905	4,575
Weather Crop Bulletin No. 13. June 12, 1905	4,575
Weather Crop Bulletin No. 14. June 19, 1905	4,575
Weather Crop Bulletin No. 15. June 26, 1905	4,575
Periodic Variation of Rainfall in the Arid Region. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau, by William B. Stockman, Chief Division of Meteorological Records. Pp. 15, map. Bulletin N. (W. B. No. 326.) March 24, 1905. Price, 10 cents	5,000

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	Copies.
Proceedings of the Third Convention of Weather Bureau Officials, Held at Peoria, Ill., September 20, 21, 22, 1904. Published by authority of the Secretary of Agriculture under the direction of Chief of Weather Bureau. Pp. 267. May 8, 1905	5,000
The Weather Bureau and the Homeseeker. By Edward L. Wells, Observer, Weather Bureau. Pp. ii, 353–358. (From Yearbook of the Department of Agriculture for 1904.) June 9, 1905	1,000
Relation of Weather Conditions to Growth and Development of Cotton. By J. B. Marbury, Section Director, United States Weather Bureau, Atlanta, Ga. Pp. v, 141–150. (From Yearbook of Department of Agriculture for 1904.) June 10, 1905	1,000
Meteorological Chart of the Great Lakes. No. 1. 1904. By Alfred J. Henry and Norman B. Conger. Prepared under direction of Willis L. Moore, Chief U. S. Weather Bureau. Pp. 30, figs. 6. (W. B. No. 309.) August 10, 1904. Price, 10 cents	2,800
Climate: Its Physical Basis and Controlling Factors. By Willis L. Moore, Chief U. S. Weather Bureau. Pp. 19. Bulletin No. 34. (W. B. No. 311.) August 27, 1904	15,000
Invariability of Our Winter Climate. By Wm. B. Stockman, District Forecaster, in Charge of Division of Meteorological Records. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. Pp. 5. (W. B. No. 312.) October 13, 1904	1,500
On the General Circulation of the Atmosphere in Middle and High Latitudes. By W. N. Shaw, F. R. S., Secretary of the Meteorological Council. Pp. 13. (W. B. No. 314.) October 12, 1904	250
Studies on the Circulation of the Atmospheres of the Sun and of the Earth. By Frank H. Bigelow, M. A., L. H. D., Professor of Meteorology. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. Pp. iv, 44, figs. 88. October 12, 1904	1,000
Sunshine Tables. Edition of 1905. Giving the time of Sunrise and Sunset in Mean Solar Time and the Total Duration of Sunshine for Every Day in the Year, Latitude 20° to 50° North. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. By C. F. Marvin, Professor of Meteorology. Parts I, II, III. Pp. 75. January 20, 1905	800
Report of the Chief of the Weather Bureau for 1904. By Willis L. Moore. Pp. iii, 1–42. (From Annual Reports, Department of Agriculture.) January 25, 1905	2,500
Long-Range Weather Forecasts. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. By E. B. Garriott, Professor of Meteorology. Pp. 68. Bulletin No. 35. (W. B. No. 322.) February 18, 1905	25,000
Meteorological Chart of the Great Lakes. No. 2. 1904. By Alfred J. Henry and Norman B. Conger. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. Pp. 18, chart 1. (W. B. No. 324.) March 18, 1905. Price 10 cents	2,500
Evaporation Observations in the United States. By Herbert Harvey Kimball, Librarian U. S. Weather Bureau. Prepared under the direction of Willis L. Moore, Chief U. S. Weather Bureau. Pp. 4. March 24, 1905	800
Snow and Ice Bulletin. December 6, 1904	2,000
Snow and Ice Bulletin. December 13, 1904	1,750
Snow and Ice Bulletin. December 20, 1904	1,750
Snow and Ice Bulletin. December 27, 1904	1,660
Snow and Ice Bulletin. January 3, 1905	1,650
Snow and Ice Bulletin. January 10, 1905	1,660
Snow and Ice Bulletin. January 17, 1905	1,700
Snow and Ice Bulletin. January 24, 1905	1,750
Snow and Ice Bulletin. January 31, 1905	1,750
Snow and Ice Bulletin. February 7, 1905	1,750
Snow and Ice Bulletin. February 14, 1905	1,750
Snow and Ice Bulletin. February 21, 1905	1,720
Snow and Ice Bulletin. February 28, 1905	1,700
Snow and Ice Bulletin. March 7, 1905	1,730
Snow and Ice Bulletin. March 14, 1905	1,750
Snow and Ice Bulletin. March 21, 1905	1,750
Snow and Ice Bulletin. March 28, 1905	1,760

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	Copies.
Daily Weather Map (showing weather conditions throughout the United States and giving forecasts of probable changes):	
July, 1904	46,828
August, 1904	46,850
September, 1904	47,107
October, 1904	48,371
November, 1904	48,250
December, 1904	48,694
January, 1905	49,010
February, 1905	49,200
March, 1905	49,038
April, 1905	47,250
May, 1905	47,159
June, 1905	47,503

APPENDIX B.

REPORT IN DETAIL OF PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RECEIVED AND DISTRIBUTED DURING THE FISCAL YEAR ENDED JUNE 30, 1905, THE PUBLICATION OF WHICH IS PROVIDED FOR BY LAW.

[NOTE.—The publications of the Weather Bureau are not distributed from the Division of Publications, but by an official in that Bureau specially charged with such work, and directed by the order of the Secretary of Agriculture, dated March 29, 1897, to report to the chief of this Division. A list of Weather Bureau publications is given in separate tables.]

Publications other than Farmers' Bulletins received and distributed from July 1, 1904 to June 30, 1905.

Publications.	Received.	Distributed.[a]
Publications on hand July 1, 1904	[b] 491,600	[b] 310,500
OFFICE OF APPOINTMENT CLERK.		
Report of the Appointment Clerk, 1904	500	500
DIVISION OF ACCOUNTS AND DISBURSEMENTS.		
Report of Chief of Division of Accounts and Disbursements, 1904	300	300
BUREAU OF ANIMAL INDUSTRY.		
Report of the Chief, 1904	200	200
Bulletin No. 28 (reprint)	200	164
Bulletin No. 29	1,000	678
Bulletin No. 31	1,000	512
Bulletin No. 34	500	790
Bulletin No. 37	500	569
Bulletin No. 39, part 7	2,000	1,586
Bulletin No. 39, part 8	2,000	1,077
Bulletin No. 39, part 9	2,000	1,483
Bulletin No. 39, part 10	2,000	1,484
Bulletin No. 39, part 11	2,000	1,588
Bulletin No. 44 (reprint)	2,000	1,086
Bulletin No. 47	1,000	1,120
Bulletin No. 52, part 2	2,436	2,436
Bulletin No. 52, part 3	1,500	759
Bulletin No. 54	200	98
Bulletin No. 56	700	750
Bulletin No. 58	5,000	4,324
Bulletin No. 59	5,000	1,926
Bulletin No. 60	1,500	1,216
Bulletin No. 61	1,000	1,000
Bulletin No. 62	5,500	4,510

[a] Where the number distributed is greater than the number received, the difference is accounted for by the number on hand at the beginning of the year.
[b] Miscellaneous publications printed prior to July 1, 1904.

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Publications other than Farmers' Bulletins received and distributed from July 1, 1904, to June 30, 1905—Continued.

Publications.	Received.	Distributed.
BUREAU OF ANIMAL INDUSTRY—continued.		
Bulletin No. 63	5,900	4,591
Bulletin No. 64	3,000	2,467
Bulletin No. 65	3,200	2,680
Bulletin No. 66	3,500	1,762
Bulletin No. 67	3,900	3,122
Bulletin No. 68	8,000	6,012
Bulletin No. 69	4,000	2,958
Bulletin No. 70	4,000	2,307
Bulletin No. 71	4,500	4,328
Bulletin No. 72	6,000	1,142
Circular No. 1 (reprint)	1,000	447
Circular No. 7 (reprint)	1,000	272
Circular No. 8 (reprint)	2,000	1,395
Circular No. 19 (reprint)	2,000	632
Circular No. 23 (reprint)	15,000	10,729
Circular No. 31 (reprint)	5,000	6,122
Circular No. 35 (reprint)	3,000	1,863
Circular No. 47 (reprint)	1,500	1,500
Circular No. 48 (reprint)	6,500	5,448
Circular No. 49 (reprint)	2,000	2,000
Circular No. 50 (reprint)	4,000	3,237
Circular No. 51 (reprint)	5,000	4,084
Circular No. 52	1,100	813
Circular No. 53	1,200	1,200
Circular No. 54	550	550
Circular No. 55	2,300	1,543
Circular No. 56	5,500	3,865
Circular No. 57	1,500	924
Circular No. 58	1,200	741
Circular No. 59	1,500	1,322
Circular No. 60	1,300	836
Circular No. 61	1,200	997
Circular No. 62	1,200	580
Circular No. 63	3,000	1,715
Circular No. 64	2,500	1,836
Circular No. 65	3,000	2,853
Circular No. 66	3,500	3,400
Circular No. 67	3,500	2,588
Circular No. 68	3,500	3,388
Circular No. 69	3,500	3,400
Circular No. 70	3,500	3,500
Circular No. 71	3,500	2,713
Circular No. 72	1,000	1,000
Circular No. 73	2,000	771
Circular No. 74	1,000	795
Circular No. 75	2,000	115
Circular No. 77	1,000	136
Circular No. 78	4,000	2,000
Circular No. 79	2,000	111
Circular No. 80	2,000	432
Twentieth Annual Report Bureau Animal Industry	9,000	6,505
American Saddle Horse (reprint from Nineteenth Annual Report Bureau Animal Industry)	1,000	483
Distribution and Magnitude of the Poultry and Egg Industry	1,000	881
Special Report on the Diseases of Cattle	5,000	1,877
BIOLOGICAL SURVEY.		
Report of the Chief, 1904	1,500	700
Bulletin No. 9 (reprint)	1,500	133
Bulletin No. 10 (reprint)	1,500	60
Bulletin No. 13 (reprint)	1,500	177
Bulletin No. 15 (reprint)	1,500	198
Bulletin No. 17 (reprint)	1,000	580
Bulletin No. 18	2,000	1,292
Bulletin No. 19	5,000	4,113
Bulletin No. 20	5,000	3,250
Circular No. 17 (reprint)	1,500	1,183
Circular No. 43 (reprint)	1,500	1,357
Circular No. 44 (reprint)	1,000	1,000
Circular No. 45	700	700
Circular No. 46	3,000	3,000
Circular No. 47	2,500	2,010
Circular No. 48	250	204
North American Fauna, No. 24	3,500	2,042

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Publications other than Farmers' Bulletins received and distributed from July 1, 1904, to June 30, 1905—Continued.

Publications.	Received.	Distributed.
BUREAU OF CHEMISTRY.		
Report of Chemist, 1904	500	327
Bulletin No. 13, part 9 (reprint)	1,000	633
Bulletin No. 13, part 10 (reprint)	500	495
Bulletin No. 46 (reprint)	1,000	704
Bulletin No. 65 (reprint)	500	840
Bulletin No. 68 (reprint)	500	350
Bulletin No. 69, part 1 (reprint)	500	447
Bulletin No. 69, part 2 (reprint)	500	432
Bulletin No. 69, part 3 (reprint)	500	453
Bulletin No. 69, part 4 (reprint)	500	410
Bulletin No. 69, part 5 (reprint)	500	573
Bulletin No. 70 (reprint)	1,500	470
Bulletin No. 71 (reprint)	1,000	1,038
Bulletin No. 74 (reprint)	500	85
Bulletin No. 77 (reprint)	1,000	659
Bulletin No. 81 (reprint)	1,000	993
Bulletin No. 83, part 1 (reprint)	1,000	865
Bulletin No. 83, part 2	3,000	547
Bulletin No. 84, part 1	1,000	811
Bulletin No. 85	5,000	3,980
Bulletin No. 86	3,000	2,648
Bulletin No. 87	4,000	2,430
Bulletin No. 88	4,500	4,339
Bulletin No. 89	3,500	2,318
Bulletin No. 92	2,436	2,343
Circular No. 12 (reprint)	300	368
Circular No. 14	15,000	13,089
Circular No. 15	7,500	7,131
Circular No. 16	6,800	5,614
Circular No. 17	8,000	6,714
Circular No. 18	10,000	8,854
Circular No. 19	350	350
Circular No. 20	1,800	1,672
Circular No. 21	10,000	6,842
Circular No. 22	1,600	1,550
Circular No. 23	1,500	1,320
Report of Cooperative Work on the Dalican Titer Test. (Reprint from Chemistry Bul. 81)	200	200
Progress of Beet-Sugar Industry in United States in 1903	6,000	4,300
ENTOMOLOGY.		
Report of the Entomologist, 1904	200	200
Bulletin No. 1 (reprint)	1,000	711
Bulletin No. 3 (reprint)	1,000	375
Bulletin No. 38 (reprint)	1,000	118
Bulletin No. 43 (reprint)	1,000	570
Bulletin No. 45	1,000	630
Bulletin No. 47	1,000	860
Bulletin No. 49	8,500	7,095
Bulletin No. 50	1,000	897
Bulletin No. 53	1,000	585
Circular No. 9 (reprint)	2,000	362
Circular No. 11 (reprint)	2,000	371
Circular No. 12 (reprint)	2,500	843
Circular No. 13 (reprint)	2,500	1,303
Circular No. 16 (reprint)	2,000	385
Circular No. 26 (reprint)	2,000	337
Circular No. 31 (reprint)	200	340
Circular No. 32 (reprint)	2,000	300
Circular No. 34 (reprint)	2,500	1,390
Circular No. 39 (reprint)	2,000	400
Circular No. 46 (reprint)	1,000	584
Circular No. 47 (reprint)	2,000	892
Circular No. 52 (reprint)	2,500	1,687
Circular No. 56	56,000	53,500
Circular No. 57	3,000	1,804
Circular No. 58	3,000	1,732
Circular No. 59	3,500	1,777
Circular No. 60	3,500	1,958
Circular No. 61	3,500	912
Circular No. 62	3,500	958
Circular No. 63	1,000	138
Some Present Day Features of Applied Entomology (reprint from Entomology Bul. 52)	200	200

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Publications other than Farmers' Bulletins received and distributed from July 1, 1904, to June 30, 1905—Continued.

Publications.	Received.	Distributed.
OFFICE OF EXPERIMENT STATIONS.		
Report of the Director, 1904	2,500	2,309
Bulletin No. 28 (reprint)	1,500	1,287
Bulletin No. 31 (reprint)	250	5
Bulletin No. 33 (reprint)	500	409
Bulletin No. 63 (reprint)	300	176
Bulletin No. 101 (reprint)	500	250
Bulletin No. 102 (reprint)	500	56
Bulletin No. 112	1,000	795
Bulletin No. 124	3,000	2,135
Bulletin No. 136	800	491
Bulletin No. 142 (reprint)	300	455
Bulletin No. 144	4,500	3,747
Bulletin No. 145	10,000	8,863
Bulletin No. 146	3,500	3,068
Bulletin No. 147	3,500	3,386
Bulletin No. 148	2,500	2,235
Bulletin No. 149	3,500	2,680
Bulletin No. 150	1,000	1,006
Bulletin No. 151	5,500	3,820
Bulletin No. 152	3,200	1,518
Bulletin No. 154	5,000	1,615
Circular No. 23 (reprint)	500	288
Circular No. 34 (reprint)	2,500	2,472
Circular No. 45 (reprint)	500	255
Circular No. 46 (reprint)	1,500	1,000
Circular No. 47 (reprint)	500	145
Circular No. 49 (reprint)	3,500	1,058
Circular No. 51 (reprint)	1,500	1,500
Circular No. 52 (reprint)	5,000	6,661
Circular No. 56	1,000	331
Circular No. 59	3,000	3,000
Circular No. 60	20,000	13,008
Circular No. 61	1,000	777
Circular No. 63	2,000	135
Report of Irrigation Investigations for 1902, No. 3 (reprint from O. E. S. Bul. No. 133)	500	465
Reprints from Office Experiment Stations Bulletin No. 142:		
Cooperative Work in Economic Entomology	200	160
Methods of Conducting Investigation Relating to Maintenance or Increase of Soil Fertility	500	200
The New Jersey Ideal in the Study and Report upon Injurious Insects	100	176
Annual Report of the Alaska Agricultural Experiment Station (reprint from Annual Report O. E. S., 1902)	200	150
Reprints from Annual Report, Office of Experiment Stations, 1903:		
Development of Text-Book of Agriculture in North America	500	379
Annual Report of the Porto Rico Experiment Station, 1903	300	152
Annual Report of Alaska Experiment Station, 1903	500	925
Reprints from Annual Report, Office of Experiment Stations, 1904:		
Summary of Annual Report and Work and Expenditures of the Agricultural Experiment Stations for the Year ended June 30, 1904	1,000	30
Annual Report of the Farmers' Institute, 1904	2,000	80
Dietetics in Relation to Hospitals for the Insane	1,000	30
Some Important Foreign Veterinary Investigations	200	30
Statistics of Land-Grant Colleges and Agricultural Experiment Stations, 1904	500	30
Experiment Station Work in Corn Culture	200	30
Report of Irrigation and Drainage Investigation, 1904	1,000	30
Annual Report Alaska Agricultural Experiment Stations, 1904	2,500	1,641
Porto Rico Report, 1904	1,000	331
General Index to Experiment Station Record, Vols. I–XII, inclusive, 1889–1901	1,500	1,451
Experiment Station Record:		
Vol. I, No. 3 (reprint)	200	6
Vol. I, No. 4 (reprint)	200	6
Vol. I, No. 5 (reprint)	200	4
Vol. I, No. 6 (reprint)	200	6
Vol. II, No. 2 (reprint)	200	18
Vol. II, No. 9 (reprint)	200	16
Vol. V, No. 1 (reprint)	200	25
Vol. V, No. 11 (reprint)	200	20
Vol. VII, No. 2 (reprint)	200	6
Vol. VIII, No. 1 (reprint)	200	6
Vol. VIII, No. 2 (reprint)	200	8
Vol. VIII, No. 3 (reprint)	200	38
Vol. VIII, No. 4 (reprint)	200	8
Vol. VIII, No. 5 (reprint)	200	6
Vol. VIII, No. 6 (reprint)	200	4
Vol. VIII, No. 7 (reprint)	200	6
Vol. VIII, No. 8 (reprint)	200	6
Vol. VIII, No. 9 (reprint)	200	6

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Publications other than Farmers' Bulletins received and distributed from July 1, 1904, to June 30, 1905—Continued.

Publications.	Received.	Distributed.
OFFICE OF EXPERIMENT STATIONS—continued.		
Experiment Station Record—Continued.		
Vol. VIII, No. 10 (reprint)	200	6
Vol. VIII, No. 11 (reprint)	200	6
Vol. XIV, No. 1 (reprint)	300	30
Vol. XV, No. 11	6,000	6,000
Vol. XV, No. 12	6,000	6,000
Vol. XVI, No. 1	6,500	6,000
Vol. XVI, No. 2	6,000	6,000
Vol. XVI, No. 3	6,000	6,000
Vol. XVI, No. 4	6,000	6,000
Vol. XVI, No. 5	6,000	5,863
Vol. XVI, No. 6	6,000	6,000
Vol. XVI, No. 7	6,500	6,225
Vol. XVI, No. 8	6,500	5,983
Vol. XVI, No. 9	6,500	5,277
Vol. XVI, No. 10	6,500	4,387
The Respiration Calorimeter at the Pennsylvania Experiment Station (reprint from O. E. S. Record, Vol. XV, No. 11)	500	500
New Live Stock Building at the Minnesota College of Agriculture (reprint from O. E. S. Record, Vol. XVI, No. 1)	300	125
Experiment Station Men in the Dual Role of Instructors and Investigators (reprint from O. E. S. Record, Vol. XVI, No. 4)	500	150
New Agriculture Building at the North Carolina College of Agriculture and Mechanic Arts (reprint from O. E. S. Record, Vol. XVI, No. 6)	200	200
Experiment Station Work:		
Vol. II, No. 6	3,000	2,900
Vol. II, No. 7	3,000	2,789
Vol. II, No. 8	3,000	2,900
Vol. II, No. 9	3,000	2,080
Porto Rico Bulletin No. 4 (English edition)	3,000	3,000
Porto Rico Bulletin No. 4 (Spanish edition)	3,000	2,000
Porto Rico Bulletin No. 5 (English edition)	2,000	2,000
Hawaii Bulletin No. 8	3,500	3,490
O. E. S. Doc. No. 708. Organization and Work of Agricultural Experiment Stations in United States	5,000	3,000
O. E. S. Doc. No. 711. Farmers' Institutes in United States	5,000	1,800
O. E. S. Doc. No. 713. Investigation on the Nutrition of Man in United States.	5,000	2,000
O. E. S. Doc. 723. Irrigation and Drainage Investigation of the United States.	5,000	5,000
BUREAU OF FORESTRY.		
Report of the Forester, 1904	2,500	2,275
Bulletin No. 7 (reprint)	1,000	674
Bulletin No. 13 (reprint)	2,000	200
Bulletin No. 24, part 2	40,000	24,321
Bulletin No. 42 (reprint)	10,000	1,481
Bulletin No. 46 (reprint)	10,000	8,022
Bulletin No. 47 (reprint)	10,000	7,326
Bulletin No. 48 (reprint)	10,000	8,307
Bulletin No. 49 (reprint)	10,000	8,307
Bulletin No. 50 (reprint)	5,000	3,010
Bulletin No. 51	10,000	7,098
Bulletin No. 52	10,000	8,340
Bulletin No. 53	10,000	10,000
Bulletin No. 54	10,000	7,249
Bulletin No. 55	10,000	7,122
Bulletin No. 57	1,000	1,000
Bulletin No. 60	10,000	9,300
Insects Injurious to the Basket Willow (reprint from Forestry Bul. No. 46)	300	115
Circular No. 21 (reprint)	20,500	20,500
Circular No. 22 (reprint)	25,500	20,500
Circular No. 23	5,000	5,390
Circular No. 29	50,000	48,307
Circular No. 30	50,000	45,765
Circular No. 31	50,000	48,520
Circular No. 32	15,000	13,494
Circular No. 33	30,000	28,552
Circular No. 34	10,000	7,663
Public Lands Commission	200,000	4,000
LIBRARY.		
Report of the Librarian, 1904	250	200
Bulletin No. 51	1,000	1,000
Bulletin No. 52	1,000	900
Bulletin No. 53	1,000	923
Bulletin No. 54	1,000	815

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Publications.	Received.	Distributed.
BUREAU OF PLANT INDUSTRY.		
Report of the Chief, 1904	500	500
Bulletin No. 3 (reprint)	2,000	806
Bulletin No. 20 (reprint)	1,000	239
Bulletin No. 30 (reprint)	2,000	551
Bulletin No. 48 (reprint)	2,000	1,110
Bulletin No. 51	2,000	1,687
Bulletin No. 51, part 4	3,000	2,343
Bulletin No. 51, part 5	3,000	2,611
Bulletin No. 51, part 6	5,000	3,814
Bulletin No. 56	1,000	1,000
Bulletin No. 61	3,500	2,000
Bulletin No. 62	3,500	1,782
Bulletin No. 63	3,500	2,792
Bulletin No. 64 (reprint)	2,000	2,133
Bulletin No. 66	1,000	1,000
Bulletin No. 67	5,000	4,128
Bulletin No. 68	2,500	2,012
Bulletin No. 69	5,000	3,361
Bulletin No. 70	10,500	7,989
Bulletin No. 71	11,000	10,643
Bulletin No. 72	2,000	1,146
Bulletin No. 72, part 1	2,500	1,564
Bulletin No. 72, part 2	3,500	1,506
Bulletin No. 72, part 3	4,000	3,737
Bulletin No. 72, part 4	25,000	3,488
Bulletin No. 73	3,500	2,802
Bulletin No. 74	3,500	3,500
Bulletin No. 75	4,500	4,046
Bulletin No. 76	4,000	3,144
Botany.		
Bulletin No. 28 (reprint)	1,000	135
Circular No. 18 (reprint)	3,000	3,000
Circular No. 27 (reprint)	3,000	310
Pomology.		
Bulletin No. 8 (reprint)	2,000	571
PUBLICATIONS.		
Report of the Editor, 1904	1,500	1,009
Bulletin No. 7 (reprint)	500	86
Circular No. 1 (reprint)	2,500	1,493
Monthly List of Publications, June, 1904	137,500	137,500
Foreign Monthly List of Publications, June, 1904	2,500	2,500
Monthly List of Publications, July, 1904	137,500	137,500
Foreign Monthly List of Publications, July, 1904	2,500	2,500
Monthly List of Publications, August, 1904	137,500	137,500
Foreign Monthly List of Publications, August, 1904	2,500	2,500
Monthly List of Publications, September, 1904	137,500	137,500
Foreign Monthly List of Publications, September, 1904	2,500	2,500
Monthly List of Publications, October, 1904	137,500	137,500
Foreign Monthly List of Publications, October, 1904	2,500	2,500
Monthly List of Publications, November, 1904	137,500	137,500
Foreign Monthly List of Publications, November, 1904	2,500	2,500
Monthly List of Publications, December, 1904	137,500	137,500
Foreign Monthly List of Publications, December, 1904	2,500	2,500
Monthly List of Publications, January, 1905	142,000	142,000
Foreign Monthly List of Publications, January, 1905	2,500	2,500
Monthly List of Publications, February, 1905	145,000	145,000
Foreign Monthly List of Publications, February, 1905	2,500	2,500
Monthly List of Publications, March, 1905	147,000	147,000
Foreign Monthly List of Publications, March, 1905	2,500	2,500
Monthly List of Publications, April, 1905	147,500	147,500
Foreign Monthly List of Publications, April, 1905	2,500	2,500
Monthly List of Publications, May, 1905	147,500	147,500
Foreign Monthly List of Publications, May, 1905	2,500	2,500
List of Publications for Sale by Superintendent of Documents (No. 179, 12th edition)	10,000	8,000
List of Available Publications of the Department of Agriculture (No. 247, 12th edition)	10,000	10,000
ROADS.		
Bulletin No. 24 (reprint)	2,000	2,516
Circular No. 30 (reprint)	2,000	347
Circular No. 37 (reprint)	5,000	2,180
Report of the Office of Public Road Inquiries, 1904	2,000	1,200

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Publications.	Received.	Distributed.
OFFICE OF THE SECRETARY.		
Report No. 79	50,000	41,020
Report No. 80	8,000	1,670
Circular No. 11	1,500	626
Circular No. 12	47,000	47,000
Circular No. 13	7,100	4,469
Preliminary Report of the Secretary, 1904	5,000	4,688
Annual Report of Department, 1904	3,000	1,548
Report on the New Department Buildings for 1904 (from Annual Report Dept. Agriculture, 1904)	250	250
Yearbook Department of Agriculture, 1904	30,000	6,976
	1,500	1,891
Extracts from Yearbooks.		
No. 37, part 1, Four Common Birds		
No. 37, part 2, The Meadow Lark and Baltimore Oriole	1,500	1,789
No. 66, The Blue Jay	2,500	1,600
No. 104, Popular Education for the Farmer in the United States	500	282
No. 118, Office of Road Inquiry—Object Lesson Roads	1,000	730
No. 133, Birds as Weed Destroyers	3,500	2,047
No. 179, Progress of Agriculture in the United States	1,000	636
No. 194, Food of Nestling Birds	1,500	3,000
No. 197, How Birds Affect the Orchards	5,500	2,971
No. 204, The Selection of Material for Macadam Roads	1,000	368
No. 247, Two Vanishing Game Birds	1,500	1,097
No. 262, The Contamination of Public Water Supplies by Algæ		
No. 263, Audubon Societies in Relation to the Farmer	2,000	1,000
No. 266, Top-Working Orchard Trees	4,000	1,600
No. 277, Bacteria and the Nitrogen Problem	4,000	4,632
No. 279, Improvement of Corn by Seed Selection	10,000	8,541
No. 282, Flax Seed Production, etc	1,000	510
No. 287, Improvement of Cotton by Seed Selection	10,000	13,199
No. 289, Practices in Crop Rotation	500	500
No. 293, Cultivation and Fertilization of Peach Orchards	1,000	1,036
No. 296, Use of Mineral Oil in Road Improvement	2,000	738
No. 314, The Growing of Long-Staple Upland Cotton	10,000	12,141
No. 317, Relation of Cold Storage to Commercial Apple Culture	6,200	3,200
No. 320, Relation of Sugar Beets to General Farming	500	437
No. 322, Some New Facts About Migration of Birds	2,000	1,800
No. 323, A Model Farm	13,800	16,569
No. 328, Determination of Effect of Preservatives in Food on Health, etc	500	500
No. 329, The Relation of Forests to Stream Flow	2,000	12,200
No. 330, Promising New Fruits	5,000	1,500
No. 331, The Adulteration of Drugs	500	397
No. 335, The Principal Injurious Insects, 1903	200	200
No. 336, The Relation of Plant Physiology to Development of Agriculture	500	25
No. 337, The Attitude of Lumbermen toward Forest Fires	20,000	5
No. 338, Relation of Weather Conditions to Growth and Development of Cotton	1,000	5
No. 339, Inspection of Foreign Food Products	500	30
No. 340, Opportunities in Agriculture	2,000	786
No. 341, Present Status of the Cotton Boll Weevil in the United States	250	183
No. 342, The Respiration Calorimeter	10,000	30
No. 344, The Relation of Birds to Fruit Growing in California	5,000	206
No. 346, Agricultural Development in Argentina	500	4
No. 347, The Castor Oil Industry	2,000	10
No. 349, Potato Culture near Greeley, Colo	500	5
No. 350, Practical Road Building in Madison County, Tenn	5,000	1,000
No. 352, The Weather Bureau and the Home Seeker	1,000	10
No. 354, Some Uses of the Grapevine and its Fruit	2,000	25
No. 355, Insects Injurious to Forest Products	2,000	205
No. 357, Consumers' Fancies	4,000	2,942
No. 359, The Determination of Timber Values	20,000	200
No. 360, The Annual Loss Occasioned by Destructive Insects in the United States	2,000	1,504
No. 361, Cotton Culture in Guatemala	1,000	50
No. 363, Work of the Bureau of Plant Industry in Meeting the Ravages of the Boll Weevil, etc	2,000	2,000
No. 364, Some Benefits the Farmer May Derive from Game Protection	5,000	1,095
No. 365, State Publications on Agriculture	500	5
No. 367, Plant Diseases in 1904	500	10
No. 368, The Principal Injurious Insects, 1904	500	256
No. 370, Statistical Matter	10,000	1,875
No. 371, Game Protection in 1904	5,000	
No. 372, Progress of Forestry in 1904	30,000	210
BUREAU OF STATISTICS.		
Report of the Statistician, 1904	1,000	200
Bulletin No. 28	25,000	21,844
Bulletin No. 29	4,600	3,932
Bulletin No. 30	13,000	12,025

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Publications.	Received.	Distributed.
BUREAU OF STATISTICS—continued.		
Bulletin No. 31	4,000	3,247
Bulletin No. 32	4,500	3,063
Bulletin No. 33	4,000	2,900
Circular No. 16	4,300	3,474
Crop Reporter:		
Supplement to Vol. 3, No. 12 (reprint)	500	500
Vol. 6, No. 3. July, 1904	100,000	100,000
Vol. 6, No. 4. August, 1904	100,000	100,000
Vol. 6, No. 5. September, 1904	100,000	100,000
Vol. 6, No. 6. October, 1904	100,000	100,000
Vol. 6, No. 7. November, 1904	100,000	100,000
Vol. 6, No. 8. December, 1904	100,000	100,000
Supplement to Vol. 6, No. 8. December, 1904	100,000	100,000
Vol. 6, No. 9. January, 1905	100,000	100,000
Vol. 6, No. 10. February, 1905	105,000	105,000
Vol. 6, No. 11. March, 1905	105,000	105,000
Vol. 6, No. 12. April, 1905	105,000	105,000
Vol. 7, No. 1. May, 1905	105,000	105,000
Vol. 7, No. 2. June, 1905	105,000	105,000
Foreign markets.		
Bulletin No. 30	1,000	1,000
Bulletin No. 34	6,000	3,675
BUREAU OF SOILS.		
Report of the Chief, 1904	200	200
Bulletin No. 11 (reprint)	500	280
Bulletin No. 23	2,500	2,500
Bulletin No. 24	2,500	1,600
Bulletin No. 25	2,100	1,542
Bulletin No. 26	1,000	1,000
Bulletin No. 27	6,000	3,193
Circular No. 13 (reprint)	9,000	11,127
Circular No. 14	4,000	1,600
Circular No. 15	3,500	1,719
Report of Field Operations for 1903	6,000	4,135
Advance Sheets of Field Operations for 1903:		
Soil Survey of the Lufkin Area, Texas	1,000	466
Soil Survey of Miller County, Arkansas	1,000	466
Soil Survey of the Russell Area, Kansas	1,000	451
Soil Survey of Mason County, Kentucky	1,000	347
Soil Survey of the Jacksonville Area, Texas	1,000	475
Soil Survey of the Woodville Area, Texas	1,000	727
Soil Survey of the Dover Area, Delaware	1,000	315
Soil Survey of the Nacogdoches Area, Texas	1,000	312
Soil Survey of the Fargo Area, North Dakota	1,000	584
Soil Survey of the Lockhaven Area, Pennsylvania	1,000	349
Soil Survey of McLean County, Illinois	1,000	882
Soil Survey of the Ashtabula Area, Ohio	1,000	368
Soil Survey of Worcester County, Maryland	1,000	727
Soil Survey of the Norfolk Area, Virginia	1,000	463
Soil Survey of the Syracuse Area, New York	1,000	481
Soil Survey of the Connecticut Valley	1,000	425
Soil Survey of the Brookings Area, South Dakota	1,000	421
Soil Survey of the Pontiac Area, Michigan	1,000	403
Soil Survey of the Marshall Area, Minnesota	1,000	402
Soil Survey of Johnson County, Illinois	1,000	435
Soil Survey of the San Jose Area, California	1,000	667
Soil Survey of Sangamon County, Illinois	1,000	380
Soil Survey of Madison County, Indiana	1,000	347
Soil Survey of the Asheville Area, North Carolina	1,000	498
Soil Survey of the Leesburg Area, Virginia	1,000	365
Soil Survey of the Parsons Area, Kansas	1,000	348
Soil Survey of the McNeill Area, Mississippi	1,000	468
Soil Survey of the Fort Valley, Georgia	1,000	389
Soil Survey of Gadsden County, Florida	1,000	393
Soil Survey of Scott County, Kentucky	1,000	341
Soil Survey of the Grand Island Area, Nebraska	1,000	441
Soil Survey of Knox County, Illinois	1,000	411
Soil Survey of the Mobile Area, Alabama	1,000	617
Soil Survey of Shelby County, Missouri	1,000	376
Soil Survey of Acadia Parish, Louisiana	1,000	529
Soil Survey of the Stanton Area, Nebraska	1,000	363
Soil Survey of the Viroqua Area, Wisconsin	1,000	351
Soil Survey of the Solomonsville Area, Arizona	1,000	349
Soil Survey of the Indio Area, California	1,000	413
Soil Survey of the Craven Area, North Carolina	1,000	477
Soil Survey of the Fort Payne Area, Alabama	1,000	391
Soil Survey of the Long Island Area, New York	1,000	786

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Publications other than Farmers' Bulletins received and distributed from July 1, 1904, to June 30, 1905—Continued.

Publications.	Received.	Distributed.
BUREAU OF SOILS—continued.		
Advance Sheets of Field Operations for 1903—Continued.		
Soil Survey of the Jamestown Area, North Dakota	1,000	437
Soil Survey of the Huntsville Area, Alabama	1,000	348
Soil Survey of the Imperial Area, California	1,000	448
Soil Survey of the Los Angeles Area, California	1,000	359
Soil Survey of the Salem Area, Oregon	1,000	380
Soil Survey of Winnebago County, Illinois	1,000	548
Soil Survey of the Paris Area, Texas	1,000	562
Soil Survey of Ouachita Parish, Louisiana	1,000	694
Soil Survey of the Pikeville Area, Tennessee	1,000	315
Soil Survey of the Baker City Area, Oregon	1,000	303
Soil Survey of the San Luis Valley, Colorado	1,000	554
Soil Survey of Cerro Gordo County, Iowa	1,000	443
Soil Survey of the Laramie Area, Wyoming	1,000	290
Soil Survey of the Provo Area, Utah	1,000	245
Soil Survey of the Blackfoot Area, Idaho	1,000	563
Soil Survey of the New Orleans Area, Louisiana	1,000	573
Soil Survey of the Campobello Area, South Carolina	1,000	360
Soil Survey of Davidson County, Tennessee	1,000	388
WEATHER BUREAU.		
Report of the Chief, 1904	2,500	2,431

Farmers' bulletins printed and Congressional and miscellaneous distribution for the fiscal year 1904–5.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.[a]	Miscellaneous distribution.[a]
16	Leguminous Plants	2,600	11,461	8,417
17	Peach Yellows and Peach Rosette	3,600	1,000	342
20	Washed Soils	100	1,006	143
22	The Feeding of Farm Animals	67,250	57,521	16,061
24	Hog Cholera and Swine Plague	50,200	53,468	17,575
25	Peanuts: Culture and Uses	20,900	11,028	12,352
27	Flax for Seed and Fiber		2,538	3,627
28	Weeds and How to Kill Them	50,428	31,938	15,229
29	Souring and Other Changes in Milk	30,000	15,713	12,222
30	Grape Diseases on the Pacific Coast		2,927	3,856
31	Alfalfa and Lucern	32,197	19,120	13,707
32	Silos and Silage	11,100	17,131	10,190
33	Peach Growing for Market	28,290	19,110	10,421
34	Meats: Composition and Cooking	31,900	21,088	18,690
35	Potato Culture	55,400	39,862	24,469
36	Cotton Seed and Its Products	10,000	13,093	7,584
37	Kafir Corn: Culture and Uses	10,000	13,123	12,335
38	Spraying for Fruit Diseases	30,800	32,458	13,791
39	Onion Culture	40,000	23,648	17,748
41	Fowls: Care and Feeding	75,400	60,298	21,344
42	Facts about Milk	57,800	39,800	15,880
43	Sewage Disposal on the Farm	13,000	9,147	13,983
44	Commercial Fertilizers	37,000	25,211	15,180
45	Some Insects Injurious to Stored Grain	10,018	15,782	6,015
46	Irrigation in Humid Climates		5,143	4,261
47	Insects Affecting the Cotton Plant	11,000	17,771	4,895
48	The Manuring of Cotton	21,200	25,517	5,718
49	Sheep Feeding	28,500	17,126	9,983
50	Sorghum as a Forage Crop	21,600	17,312	8,431
51	Standard Varieties of Chickens	101,600	81,491	21,722
52	The Sugar Beet	31,100	17,585	9,103
53	How to Grow Mushrooms		6,628	3,064
54	Some Common Birds	30,000	26,412	15,469
55	The Dairy Herd	44,500	38,932	10,284
56	Experiment Station Work—I	20,291	9,957	14,779
57	Butter Making on the Farm	40,500	31,671	11,300
58	The Soy Bean as a Forage Crop	10,000	7,344	8,644
59	Bee Keeping	33,385	17,990	15,314
60	Methods of Curing Tobacco	20,000	13,951	5,148
61	Asparagus Culture	30,000	17,059	11,416
62	Marketing Farm Produce	37,500	25,142	11,990
63	Care of Milk on the Farm	56,600	50,773	19,158
64	Ducks and Geese	46,500	32,428	16,897
65	Experiment Station Work—II	15,000	13,904	7,563
66	Meadows and Pastures	35,000	24,414	15,368

[a] Where the number distributed is greater than the number received, the difference is accounted for by the number on hand at the beginning of the year.

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Farmers' bulletins printed and Congressional and miscellaneous distribution for the fiscal year 1904–5—Continued.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.	Miscellaneous distribution.
68	The Black Rot of the Cabbage	20,600	17,210	6,454
69	Experiment Station Work—III	.....	11,903	10,607
70	Insect Enemies of the Grape	.....	8,023	8,978
71	Essentials in Beef Production	30,000	28,885	9,879
72	Cattle Ranges of the Southwest	.....	3,908	4,172
73	Experiment Station Work—IV	10,000	7,201	12,681
74	Milk as Food	35,000	22,873	12,375
75	The Grain Smuts	11,414	13,228	9,427
77	The Liming of Soils	10,600	15,502	18,221
78	Experiment Station Work—V	.....	8,642	7,551
79	Experiment Station Work—VI	10,000	11,388	6,011
80	The Peach Twig-borer	10,000	11,019	7,096
81	Corn Culture in the South	38,000	34,071	10,025
82	The Culture of Tobacco	10,000	10,843	5,248
83	Tobacco Soils	.....	8,915	4,579
84	Experiment Station Work—VII	25,200	11,708	11,205
85	Fish as Food	25,000	15,926	13,368
86	Thirty Poisonous Plants	25,000	14,403	15,473
87	Experiment Station Work—VIII	15,000	9,698	14,917
88	Alkali Lands	.....	5,288	4,324
89	Cowpeas	31,000	19,123	15,763
91	Potato Diseases and Treatment	45,000	34,020	20,198
92	Experiment Station Work—IX	10,000	9,280	11,301
93	Sugar as Food	.....	10,061	9,655
94	The Vegetable Garden	59,100	41,812	17,319
95	Good Roads for Farmers	71,000	63,661	12,251
96	Raising Sheep for Mutton	35,000	26,856	7,697
97	Experiment Station Work—X	21,800	11,114	15,757
98	Suggestions to Southern Farmers	25,400	25,951	9,715
99	Insect Enemies of Shade Trees	12,057	12,143	5,875
100	Hog Raising in the South	41,838	38,920	16,035
101	Millets	.....	7,766	7,400
102	Southern Forage Plants	27,586	26,723	10,947
103	Experiment Station Work—XI	32,255	13,164	13,490
104	Notes on Frost	.....	7,882	7,351
105	Experiment Station Work—XII	10,000	11,032	5,531
106	Breeds of Dairy Cattle	55,257	48,718	13,314
107	Experiment Station Work—XIII	20,000	9,816	12,186
108	Saltbushes	.....	2,248	3,142
109	Farmers' Reading Courses	35,000	22,013	15,908
110	Rice Culture in the United States	15,000	3,191	6,447
111	Farmers' Interest in Good Seed	36,200	28,148	11,764
112	Bread and Bread Making	31,391	26,674	14,887
113	The Apple and How to Grow It	50,000	46,009	19,174
114	Experiment Station Work—XIV	.....	10,148	8,983
115	Hop Culture in California	.....	2,013	3,173
116	Irrigation in Fruit Growing	6,230	5,569	5,554
118	Grape Growing in the South	20,500	12,689	9,618
119	Experiment Station Work—XV	20,000	10,417	16,177
120	Insects Affecting Tobacco	15,000	7,529	3,214
121	Beans, Peas, and other Legumes as Food	33,450	23,248	11,361
122	Experiment Station Work—XVI	10,000	9,473	11,856
123	Red Clover Seed: Information for Purchasers	.....	16,023	8,445
124	Experiment Station Work—XVII	30,000	11,374	11,937
125	Protection of Food Products from Injurious Temperatures	.....	5,487	6,430
126	Practical Suggestions for Farm Buildings	60,000	48,617	13,306
127	Important Insecticides	30,000	15,754	11,605
128	Eggs and Their Uses as Food	36,200	20,438	14,449
129	Sweet Potatoes	43,600	28,518	14,885
130	The Mexican Cotton Boll Weevil	.....	4,529	11,567
131	Household Tests for Detection of Oleomargarine and Renovated Butter	.....	6,176	7,887
132	Insect Enemies of Growing Wheat	20,900	14,762	5,597
133	Experiment Station Work—XVIII	25,000	12,108	12,008
134	Tree Planting in Rural School Grounds	30,900	12,241	19,349
135	Sorghum Sirup Manufacture	10,100	14,906	6,104
136	Earth Roads	36,000	30,657	11,061
137	The Angora Goat	26,000	14,731	12,190
138	Irrigation in Field and Garden	15,300	17,120	7,575
139	Emmer: A Grain for the Semiarid Regions	.....	3,324	4,491
140	Pineapple Growing	.....	2,142	3,580
141	Poultry Raising on the Farm	100,000	68,073	28,648
142	Principles of Nutrition and Nutritive Value of Food	30,900	20,365	12,841
143	The Conformation of Beef and Dairy Cattle	50,000	37,609	12,347
144	Experiment Station Work—XIX	10,000	14,767	11,142
145	Carbon Bisulphid as an Insecticide	.....	3,407	6,367
146	Insecticides and Fungicides	10,000	6,677	7,976
147	Winter Forage Crops for the South	25,843	25,441	6,378
148	Celery Culture	26,008	23,605	13,963
149	Experiment Station Work—XX	25,000	18,564	22,837
150	Clearing New Land	15,000	17,551	19,513

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Farmers' bulletins printed and Congressional and miscellaneous distribution for the fiscal year 1904–5—Continued.

No. of bulletin.	Title of bulletin.	Total number received.	Distributed to Congressmen.	Miscellaneous distribution.
151	Dairying in the South	20,400	17,087	6,417
152	Scabies in Cattle	15,000	17,136	24,985
153	Orchard Enemies in the Pacific Northwest	3,000	6,430	4,264
154	The Home Fruit Garden: Preparation and Care	60,800	49,190	20,558
155	How Insects Affect Health in Rural Districts	10,000	16,166	8,757
156	The Home Vineyard	30,000	23,350	15,310
157	The Propagation of Plants	15,000	20,258	12,089
158	How to Build Small Irrigation Ditches	25,000	17,110	9,981
159	Scab in Sheep	.....	14,856	5,785
161	Practical Suggestions for Fruit Growers	55,000	50,921	13,733
162	Experiment Station Work—XXI	35,000	21,942	16,950
163	Methods of Controlling the Boll Weevil	.....	5,435	2,202
164	Rape as a Forage Crop	15,800	14,234	11,543
165	Culture of the Silkworm	.....	2,886	5,333
166	Cheese Making on the Farm	40,000	22,004	19,810
167	Cassava	.....	4,920	3,584
168	Pearl Millets	.....	7,135	3,743
169	Experiment Station Work—XXII	25,000	23,960	9,055
170	Principles of Horse Feeding	86,300	73,770	11,115
171	The Control of the Codling Moth	.....	3,358	4,962
172	Scale Insects and Mites on Citrus Trees	.....	3,860	2,885
173	Primer of Forestry	60,000	56,195	16,208
174	Broom Corn	25,000	14,695	7,402
175	Home Manufacture and Use of Unfermented Grape Juice	10,000	16,364	16,596
176	Cranberry Culture	.....	4,476	4,558
177	Squab Raising	50,000	37,024	22,283
178	Insects Injurious in Cranberry Culture	.....	2,607	3,443
179	Horseshoeing	75,000	75,660	11,005
180	Game Laws for 1903	1,171	4,710	1,033
181	Pruning	66,250	48,038	19,405
182	Poultry as Food	65,000	60,810	18,947
183	Meat on the Farm: Butchering, Curing, etc	150,000	112,916	25,997
184	Marketing Live Stock	60,000	54,442	11,066
185	Beautifying the Home Grounds	87,033	56,830	19,990
186	Experiment Station Work—XXIII	45,000	23,184	13,102
187	Drainage of Farm Lands	70,000	54,234	15,987
188	Weeds Used in Medicine	50,000	40,039	17,801
189	Information Concerning the Mexican Cotton-Boll Weevil	10,000	11,639	9,918
190	Experiment Station Work—XXIV	40,800	38,724	10,010
191	The Cotton Bollworm	10,000	10,847	10,740
192	Barnyard Manure	86,581	75,769	18,908
193	Experiment Station Work—XXV	45,600	34,951	11,132
194	Alfalfa Seed	35,000	32,850	13,661
195	Annual Flowering Plants	75,400	59,952	16,742
196	Usefulness of the American Toad	20,000	16,304	8,143
197	Importation of Game Birds and Eggs for Propagation	.....	8,889	5,929
198	Strawberries	80,000	76,423	23,052
199	Corn Growing	150,300	146,959	23,033
200	Turkeys: Standard Breeds and Management	91,750	92,136	25,750
201	The Cream Separator on Western Farms	30,000	33,851	21,071
202	Experiment Station Work—XXVI	45,600	49,336	23,139
203	Canned Fruits, Preserves, and Jellies	171,800	127,717	34,541
204	The Cultivation of Mushrooms	40,000	18,640	18,722
205	Pig Management	94,000	72,743	18,305
206	Milk Fever and Its Treatment	50,000	25,878	15,585
207	Game Laws for 1904	50,200	25,909	14,371
208	Varieties of Fruits Recommended for Planting	81,200	65,436	15,764
209	Controlling the Boll Weevil in Cotton Seed and at Ginneries	30,000	11,930	16,547
210	Experiment Station Work—XXVII	65,500	46,176	12,638
211	The Use of Paris Green in Controlling the Cotton-Boll Weevil	30,400	8,284	16,462
212	The Cotton Bollworm	50,000	23,127	18,011
213	Raspberries	39,200	23,296	10,354
214	Beneficial Bacteria for Leguminous Crops	80,000	23,100	51,885
215	Alfalfa Growing	30,000	16,532	13,468
216	The Control of the Boll Weevil	35,600	7,165	18,292
217	Essential Steps in Securing an Early Crop of Cotton	35,800	10,467	18,262
218	The School Garden	50,000	15,873	10,316
219	Lessons from the Grain Rust Epidemic of 1904	40,500	5,078	18,653
220	Tomatoes	30,000	16,110	7,890
221	Fungous Diseases of the Cranberry	20,000	1,236	6,584
222	Experiment Station Work—XXVIII	20,200	12,200	8,000
223	Miscellaneous Cotton Insects in Texas	15,000	10	4,646
224	Canadian Field Peas	11,200	.....	2,208
225	Experiment Station Work—XXIX	30,700	9,842	6,183
226	Relation of Coyotes to Stock Raising in the West	10,000	.....	2,144
	Total	6,087,973	4,782,643	2,410,723

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Publications received and distributed by the Weather Bureau during the year ended June 30, 1905, by quarters.

Number and title of publication.	Number of copies.
QUARTER ENDED SEPTEMBER 30, 1904.	
Received.	
No. 309. Meteorological Charts of the Great Lakes, No. 1, 1904	2,800
No. 310. Monthly Weather Reviews for May, 1904	4,800
No. 311. Bulletin No. 34—Climate, its Physical Basis and Controlling Factors	15,000
No. 312. Invariability of Our Winter Climate	1,500
No. 313. Monthly Weather Reviews for June, 1904	4,800
No. 314. Circulation of the Atmosphere	250
No. 315. Monthly Weather Reviews for July, 1904	4,800
Washington Daily Weather Maps	140,785
Weather Crop Bulletins	58,825
Distributed.	
No. 292. Climatology of California—Bulletin L	11
No. 294. Weather Folk-lore—Bulletin No. 33	39
No. 298. Lake Charts, 1903	6
No. 301. Climatic Charts	13
No. 303. Floods of the Mississippi, Spring of 1903—Bulletin M	36
No. 309. Meteorological Charts of the Great Lakes, No. 1, 1904	2,750
No. 310. Monthly Weather Review for May, 1904	4,800
No. 311. Bulletin No. 34—Climate, its Physical Basis and Controlling Factors	14,400
No. 312. Invariability of Our Winter Climate	800
No. 313. Monthly Weather Review for June, 1904	4,800
No. 315. Monthly Weather Review for July, 1904	4,800
Washington Daily Weather Maps	140,785
Weather Crop Bulletins	58,825
Description of Cloud Forms	10
Report of the Chief of the Weather Bureau, 1891–92	1
Report of the Chief of the Weather Bureau, 1892–93	1
Report of the Chief of the Weather Bureau, 1893–94	2
Report of the Chief of the Weather Bureau, 1895–96	2
Report of the Chief of the Weather Bureau, 1896–97	8
Report of the Chief of the Weather Bureau, 1897–98	2
Report of the Chief of the Weather Bureau, 1898–99	4
Report of the Chief of the Weather Bureau, 1899–1900	3
Report of the Chief of the Weather Bureau, 1900–1901	6
Report of the Chief of the Weather Bureau, 1901–02	6
Report of the Chief of the Weather Bureau, 1902–03	18
Separates from the Reports of the Chief of Weather Bureau, 1897–98	5
Separates from the Reports of the Chief of Weather Bureau, 1899–00	2
Separates from the Reports of the Chief of Weather Bureau, 1900–01	2
Separates from the Reports of the Chief of Weather Bureau, 1901–02	31
Separates from the Reports of the Chief of Weather Bureau, 1902–03	24
Weather Bureau Bulletin No. 16	1
Weather Bureau Bulletin No. 22	2
Weather Bureau Bulletin No. 25	5
Weather Bureau Bulletin No. 26	36
Weather Bureau Bulletin No. 28	2
Weather Bureau Bulletin No. 30	8
Weather Bureau Bulletin No. 32	3
Weather Bureau Bulletin A	3
Weather Bureau Bulletin C	5
Weather Bureau Bulletin E	6
Weather Bureau Bulletin F	6
Weather Bureau Bulletin G	7
Weather Bureau Bulletin H	10
Weather Bureau Bulletin J	4
Weather Bureau Bulletin K	6
QUARTER ENDED DECEMBER 31, 1904.	
Received.	
No. 316. Studies on the Circulation of the Atmosphere of the Sun and of the Earth	1,000
No. 317. Monthly Weather Review for August, 1904	4,900
No. 318. Monthly Weather Review for September, 1904	4,900
No. 319. Monthly Weather Review for October, 1904	4,900
Washington daily weather maps	145,315
Weather Crop Bulletins	15,075
Snow and Ice Bulletins	22,250
Distributed.	
No. 292. Climatology of California—Bulletin L	22
No. 294. Weather Folk-lore—Bulletin No. 33	40
No. 298. Lake Charts, 1903	2
No. 301. Climatic Charts	4
No. 303. Floods of the Mississippi, Spring of 1903—Bulletin M	22

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Publications received and distributed by the Weather Bureau during the year ended June 30, 1905, by quarters—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED DECEMBER 31, 1904—continued.	
Distributed—Continued.	
No. 309. Meteorological Charts of the Great Lakes, No. 1, 1904	20
No. 311. Climate—Bulletin No. 34	154
No. 312. Invariability of Our Winter Climate	200
No. 314. Circulation of the Atmosphere	120
No. 316. Studies on the Circulation of the Atmosphere of the Sun and of the Earth	1,000
No. 317. Monthly Weather Review for August, 1904	4,900
No. 318. Monthly Weather Review for September, 1904	4,900
No. 319. Monthly Weather Review for October, 1904	4,900
Cloud Forms	26
Washington daily weather maps	145,315
Weather Crop Bulletins	15,075
Snow and Ice Bulletins	22,250
Report of the Chief of the Weather Bureau, 1891–92	1
Report of the Chief of the Weather Bureau, 1892–93	1
Report of the Chief of the Weather Bureau, 1893–94	2
Report of the Chief of the Weather Bureau, 1894–95	2
Report of the Chief of the Weather Bureau, 1895–96	2
Report of the Chief of the Weather Bureau, 1896–97	5
Report of the Chief of the Weather Bureau, 1898–99	1
Report of the Chief of the Weather Bureau, 1899–00	1
Report of the Chief of the Weather Bureau, 1900–01	1
Report of the Chief of the Weather Bureau, 1901–02	2
Report of the Chief of the Weather Bureau, 1902–03	11
Separates from Reports of the Chief of the Weather Bureau, 1891–92	1
Separates from Reports of the Chief of the Weather Bureau, 1894–95	1
Separates from Reports of the Chief of the Weather Bureau, 1895–96	1
Separates from Reports of the Chief of the Weather Bureau, 1897–98	2
Separates from Reports of the Chief of the Weather Bureau, 1898–99	1
Separates from Reports of the Chief of the Weather Bureau, 1899–00	7
Separates from Reports of the Chief of the Weather Bureau, 1901–02	14
Separates from Reports of the Chief of the Weather Bureau, 1902–03	22
Weather Bureau Bulletin No. 14	2
Weather Bureau Bulletin No. 16	2
Weather Bureau Bulletin No. 22	2
Weather Bureau Bulletin No. 25	7
Weather Bureau Bulletin No. 26	15
Weather Bureau Bulletin No. 28	2
Weather Bureau Bulletin No. 30	1
Weather Bureau Bulletin No. 32	2
Weather Bureau Bulletin A	2
Weather Bureau Bulletin C	1
Weather Bureau Bulletin E	5
Weather Bureau Bulletin F	4
Weather Bureau Bulletin G	4
Weather Bureau Bulletin H	9
Weather Bureau Bulletin J	4
Weather Bureau Bulletin K	5
QUARTER ENDED MARCH 31, 1905.	
Received.	
No. 320. Sunshine Tables, edition 1905—3 parts	800
No. 321. Monthly Weather Review for November, 1904	5,100
No. 322. Long Range Weather Forecasts—Bulletin No. 35	25,000
No. 323. Monthly Weather Review for December, 1904	5,100
No. 324. Meteorological Chart of the Great Lakes, No. 2, 1904	2,500
No. 325. Annual Meteorological Summary, 1904	5,100
No. 326. Periodic Variation of Rainfall in the Arid Region—Bulletin N	5,000
No. 327. Evaporation Observations in the United States	800
No. 328. Monthly Weather Review for January, 1905	5,100
Proceedings of the Third Convention of Weather Bureau Officials	5,000
Washington Daily Weather Maps	147,245
Weather Crop Bulletins	15,065
Snow and Ice Bulletins	22,420
Distributed.	
No. 292. Climatology of California—Bulletin L	14
No. 294. Weather Folk-lore—Bulletin No. 33	34
No. 301. Climatic Charts	13
No. 303. Floods of the Mississippi, Spring of 1903—Bulletin M	15
No. 309. Meteorological Chart of the Great Lakes, No. 1, 1904	2
No. 311. Climate—Bulletin No. 34	17
No. 312. Invariability of Our Winter Climate	28
No. 314. Circulation of the Atmosphere	23
No. 320. Sunshine Tables, edition 1905—3 parts	800

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Publications received and distributed by the Weather Bureau during the year ended June 30, 1905, by quarters—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED MARCH 31, 1905—continued.	
Distributed—Continued.	
No. 321. Monthly Weather Review for November, 1904	5,100
No. 322. Long Range Weather Forecasts—Bulletin No. 35	19,639
No. 323. Monthly Weather Review for December, 1904	5,100
No. 324. Meteorological Chart of the Great Lakes, No. 2, 1904	2,203
No. 325. Annual Meteorological Summary, 1904	5,100
No. 326. Periodic Variation of Rainfall in the Arid Region—Bulletin N	725
No. 328. Monthly Weather Review for January, 1905	5,100
Proceedings of the Third Convention of Weather Bureau Officials	5,000
Washington Daily Weather Maps	147,245
Weather Crop Bulletins	15,065
Snow and Ice Bulletins	22,420
Cloud Forms	19
Report of the Chief of the Weather Bureau, 1896–97	2
Report of the Chief of the Weather Bureau, 1901–02	3
Report of the Chief of the Weather Bureau, 1902–03	6
Separates from Reports of the Chief of the Weather Bureau, 1897–98	3
Separates from Reports of the Chief of the Weather Bureau, 1898–99	2
Separates from Reports of the Chief of the Weather Bureau, 1899–00	1
Separates from Reports of the Chief of the Weather Bureau, 1900–01	2
Separates from Reports of the Chief of the Weather Bureau, 1901–02	11
Separates from Reports of the Chief of the Weather Bureau, 1902–03	19
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Weather Bureau Bulletin No. 22	3
Weather Bureau Bulletin No. 25	5
Weather Bureau Bulletin No. 26	24
Weather Bureau Bulletin No. 28	5
Weather Bureau Bulletin No. 30	3
Weather Bureau Bulletin No. 32	5
Weather Bureau Bulletin A	3
Weather Bureau Bulletin E	4
Weather Bureau Bulletin F	4
Weather Bureau Bulletin G	6
Weather Bureau Bulletin H	9
Weather Bureau Bulletin K	9
QUARTER ENDED JUNE 30, 1905.	
Received.	
No. 329. Monthly Weather Review for February, 1905	5,100
No. 330. Monthly Weather Review for March, 1905	5,100
No. 331. Monthly Weather Review for April, 1905	5,100
Washington Daily Weather Maps	141,910
Weather Crop Bulletins	60,145
Distributed.	
No. 292. Climatology of California—Bulletin L	20
No. 294. Weather Folk-lore—Bulletin No. 33	239
No. 301. Climatic Charts	5
No. 303. Floods of the Mississippi, Spring of 1903—Bulletin M	12
No. 311. Climate—Bulletin No. 34	18
No. 312. Invariability of our Winter Climate	7
No. 314. Circulation of the Atmosphere	5
No. 322. Long Range Weather Forecasts—Bulletin No. 35	285
No. 324. Meteorological Charts of the Great Lakes, No. 2, 1904	10
No. 326. Periodic Variation of Rainfall in the Arid Region—Bulletin N	53
No. 327. Evaporation Observations in the United States	26
No. 329. Monthly Weather Review for February, 1905	5,100
No. 330. Monthly Weather Review for March, 1905	5,100
No. 331. Monthly Weather Review for April, 1905	5,100
Washington Daily Weather Maps	141,910
Weather Crop Bulletins	60,145
Cloud Forms	6
Reports of the Chief of the Weather Bureau, 1891–92	3
Reports of the Chief of the Weather Bureau, 1892–93	3
Reports of the Chief of the Weather Bureau, 1893–94	3
Reports of the Chief of the Weather Bureau, 1894–95	3
Reports of the Chief of the Weather Bureau, 1895–96	3
Reports of the Chief of the Weather Bureau, 1896–97	6
Reports of the Chief of the Weather Bureau, 1897–98	3
Reports of the Chief of the Weather Bureau, 1898–99	3
Reports of the Chief of the Weather Bureau, 1899–00	3
Reports of the Chief of the Weather Bureau, 1900–01	3
Reports of the Chief of the Weather Bureau, 1901–02	6
Reports of the Chief of the Weather Bureau, 1902–03	8
Separates from Reports of the Chief of the Weather Bureau, 1902–03	2

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Publications received and distributed by the Weather Bureau during the year ended June 30, 1905, by quarters—Continued.

Number and title of publication.	Number of copies.
QUARTER ENDED JUNE 30, 1905—continued.	
Distributed—Continued.	
Weather Bureau Bulletin No. 16	4
Weather Bureau Bulletin No. 22	3
Weather Bureau Bulletin No. 25	4
Weather Bureau Bulletin No. 26	36
Weather Bureau Bulletin No. 28	3
Weather Bureau Bulletin No. 30	12
Weather Bureau Bulletin No. 32	4
Weather Bureau Bulletin A	2
Weather Bureau Bulletin E	4
Weather Bureau Bulletin F	2
Weather Bureau Bulletin G	4
Weather Bureau Bulletin H	7
Weather Bureau Bulletin K	3

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REPORT OF THE BUREAU OF STATISTICS.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF STATISTICS,
Washington, D. C., November 3, 1905.

SIR: I have the honor to submit herewith a report on the organization and work of the Bureau of Statistics for the fiscal year ended June 30, 1905.

Respectfully,

W. M. HAYS,
Assistant Secretary, in Charge.

Hon. JAMES WILSON, *Secretary.*

THE DEVELOPMENT OF THE BUREAU OF STATISTICS.

The statistical work of the Department of Agriculture, started in 1862, has developed into wide use in serving as a basis in establishing prices of farm products. The needs of all interests require that there be published at frequent intervals during the crop season by a disinterested agency reliable information of the acreage, condition, production, and value of the principal crops, by total crop areas; also reports of live stock, by States, to serve as a basis for current prices. The industries depending on agriculture have grown to vast proportions, and not only manufactures, but transportation and mercantile business, are in more sensitive touch than ever before with the products the farmer can sell and with his power to purchase. Trade has become vastly more complex, partly owing to the rapid development of reselling on close margins to take advantage of fluctuations in prices and of dealing in futures and in options. The development of organizations to fix prices, and of other organizations to force temporary changes in prices, giving unnatural advantages to price manipulators, has led the public more and more to recognize the need for a strong agency to make comprehensive reports of actual facts relating to crops and to prospective yields, that all concerned may know how to buy and sell.

THREE CLASSES OF CROP REPORTS.

There are three classes of statistical reports of agricultural products prepared by the Federal Government:

(1) The census of agriculture, issued every tenth year by the Census Bureau of the Department of Commerce and Labor, giving a census count of all acreages and yields of crops and of all classes of farm animals, the last census having given the figures collected in 1900 of

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the crops and live stock for 1899. The reports of the Census Bureau, coming out one year in ten after the crop of that year is harvested and sold, serve only as a basis and a check, making it possible for the Bureau of Statistics of this Department, during the succeeding ten years to more accurately estimate amounts of crops in prospect or amounts annually harvested.

(2) The monthly and annual reports of this Bureau of statistics of agriculture giving acreage, condition, yields, and prices of crops, and reports of live stock, serve as bases used by markets in making current prices. The reports of this Bureau could be made more accurate if an agricultural census were taken every five years, instead of every ten, that its bases of comparison be not so far removed.

(3) These monthly reports, expressed numerically for entire crop areas, serve also as bases for the more frequent reports of changed conditions caused by marked weather changes as reported by the Weather Bureau of this Department.

CONDITIONS GOVERNING THE MAKING OF CROP REPORTS.

Various conditions govern the making of reports which influence the prices of farm products. In the case of commodities like wheat, corn, and pork, the conditions affecting prices extend over a world-wide area; in the case of hay, potatoes, and apples, which are too bulky to ship long distances, conditions affecting prices are local to large districts, and in the case of perishable commodities, such as strawberries, green vegetables, etc., conditions affecting prices are local to relatively small areas. Government crop reports deal mainly with products which are not quickly perishable, conditions affecting the prices of which cover wide areas. These prices are fixed at frequent intervals, often daily, by large market organizations, which gather information from the entire area as to the probable amount of product available, positions of any of the products on the routes of commercial movement, and the demand for the product. About these markets there are agencies which may combine to raise or lower prices artificially and temporarily, often so manipulating the prices as to destroy the needed confidence in merchandising the products, which results in unwarrantably large "handling charges" from the time the products leave the producer till they reach the consumer.

The producer should have as good a central crop-reporting agency as the buyer. Since his business is divided into many small non-cooperative units he can not have this without Government aid. The manufacturer, the dealer in actual products, and the consumer also need protection from the speculative manipulation of agencies organized to modify prices temporarily for their own advantage, and the main purpose of crop reports is that the whole people may be benefited by a knowledge of the actual facts which may influence current prices.

A knowledge which covers only parts of the area of a given crop may be misleading, because to judge for the entire area from conditions in some localities may give wrong results, hence the producer and others interested need a knowledge of the crop of the entire area expressed as a total. Reports covering part of an area, or covering the area definitely only in parts, may be used by self-interested crop-reporting agencies to mislead. The reporting agency, in order to

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enable those interested as producers, consumers, or dealers to recognize the conditions in the entire crop area, must resolve all the facts into quantitative statements, preferably a single numerical statement, as of yield for the entire area, and the market must then resolve the balances between supply and demand into current prices. Only by "weighting" reports from each district—that is, by giving to each partial report only that arithmetic weight which the acreage in the area covered by the partial report demands and assembling the whole into one statement—can the crop estimator accurately report for the whole area. Such definite forms of statement have the advantage of placing the reporting agency under responsibility to attain accuracy, also of being easily interpreted by all parties, and they are capable of comparison from month to month or from year to year, or with averages for the previous ten years.

The Bureau of Statistics, acting as a disinterested agency, has assumed the task of keeping the farmers, the dealers, and the users of farm products informed. Its reports of conditions and its estimates used by markets in establishing current prices have become a necessary part of our domestic trade and our foreign business. These monthly reports serve as guides to all intermediate reports from whatever source, which, without this monthly basis, would be too local and partial to be of much value.

NECESSITY FOR CROP REPORTS.

The purposes of the Government's reports on acreage, condition, or quantity of agricultural products promised throughout the season and on quantity and prices of farm products actually produced may be enumerated as follows:

(1) To give information to producers, consumers, and dealers of actual yields; also to report the actual conditions indicating future yields.

(2) To enable market centers better to balance supply against demand in defining current prices warranted by natural conditions.

(3) To insure whatever stability of prices a changing state of natural conditions allows.

(4) To be so certainly authentic and so comprehensive and definite for entire crop areas that interested agencies can not well discredit nor warp the figures with their own estimates and thus make wrong prices and unstable markets.

(5) To enable producers to know the facts as to the promise of prices for their crops, that false reports may not mislead them into early sales at prices wrongly made too low.

(6) To create confidence that sales and consignments by producers may be made more freely; that dealers may more safely conduct their business with lower handling charges; and that manufacturers and other consumers may more freely purchase stocks to hold, thus adding certainty and stability to their business that they may work on a less speculative basis, and thus bring more equitable returns for labor and expenditure to all interested.

(7) To make reports so frequently and give facts so soon after changes in prospective conditions occur, or so soon after actual yields are harvested, that the least possible element of uncertainty

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or speculative condition may prevail to remove prices from their normal economic place.

(8) To give production by localities or crop areas and to give local market demands so that producers may know in which market to sell and so that buyers may know where to best secure supplies, thus to equalize prices and to avoid loss from very low prices, as in case of heavy production of bulky or perishable products.

METHODS OF CROP REPORTING.

The Bureau of Statistics issues each month detailed reports relating to agricultural conditions throughout the United States, the data upon which these statements are based being obtained through a special field service, a corps of State statistical agents, and through a very large body of voluntary correspondents composed of the following classes: County correspondents, township correspondents, individual farmers, and special cotton correspondents.

A special field service is composed of ten traveling agents, each assigned to report for a given group of States. They are especially qualified by statistical training and practical knowledge of crops. They systematically travel over the districts assigned to them, carefully note the development of each crop, and keep in close touch with best-informed opinion, and render written and telegraphic reports monthly and at such other times as is required.

The State statistical agents are paid agents located in forty-three of the States. Each of these reports for his State as a unit and maintains a corps of correspondents entirely independent of those reporting directly to the Department at Washington. These State statistical aids report each month direct to the State agent on schedules furnished them. These are then tabulated and weighted according to the relative product or area of the given crop in each county represented, and summarized for the use of the State agent. Then he coordinates and analyzes them in the light of his own knowledge of conditions derived from personal observation and other sources, and prepares his monthly and other written and telegraphic reports to the Department.

There are in the United States approximately 2,800 counties of agricultural importance. In each of these counties the Department has a principal county correspondent who maintains an organization of several assistants. These county correspondents are selected with special reference to their qualifications and constitute an efficient branch of the crop-reporting service. They make the county the geographical unit of their reports, and after obtaining data each month from their assistants and supplementing this with information obtained from their own observation and knowledge, they report directly to the Department at Washington.

In the township and voting precincts in the United States in which farming operations are extensively carried on the Department has township correspondents who make the township or precinct the basis of their reports, which they also send to the Bureau of Statistics each month.

Finally, at the end of the growing season a large number of individual farmers and planters report on the results of their own individual farming operations during the year.

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With regard to cotton, all the information secured from the foregoing sources is supplemented by that furnished by special cotton correspondents, embracing a large number of persons intimately concerned in the cotton industry.

SCOPE OF CROP REPORTS.

Eleven reports on the principal crops are received yearly from each of the special field agents, county correspondents, State statistical agents, and township correspondents, and one report relating to the acreage and production of general crops is received during the year from individual farmers.

Six special cotton reports are received during the growing season from the special field agents, from the county correspondents, from the State statistical agents, and from township correspondents, and the first and last of these reports are supplemented by returns from individual farmers, special correspondents, and a list of cotton ginners kindly supplied this Bureau by the Census Bureau of the Department of Commerce and Labor.

The general reports for January and February are combined on one schedule and relate to the number and value of farm animals.

The general report for March relates to the stocks of grain in farmers' hands, the distribution and consumption of corn, wheat, and oats, and the average weight per bushel of wheat and oats.

Reports on the condition of the crops of the year begin with the April report, when the condition of winter wheat and rye is dealt with, also the sowing, germination, growth, damage by insects, and protection by snow; diseases of farm animals and losses from disease and exposure.

The report for May comes at a time when few of the crops are sufficiently advanced for their condition to be reported upon; consequently the inquiries relative to condition apply only to winter wheat, rye, meadow mowing lands, and spring pasture. This schedule also deals with the portion, if any, of the original acreage sown to winter wheat that for any reason has been or will be abandoned, and also contains inquiries with regard to farm labor and tenants.

The schedule for June deals with the acreage of six crops, the most important of which is spring wheat. It also covers the condition of wheat, oats, barley, rye, clover, spring pastures, apples, peaches, and rice.

The July schedule deals with the acreage of corn, potatoes, tobacco, and sugar cane, the stocks of wheat in farmers' hands, and the average condition of all the principal crops, fruits, spring pasture, and the average weight of wool per fleece.

The August schedule deals with the average yield of winter wheat per acre, acreage of buckwheat and hay, the condition of the principal crops, the quality of clover hay, and the stocks of oats in farmers' hands.

The September schedule deals with the condition, when harvested, of wheat, oats, barley, and rye, the acreage of clover seed, the production of peaches, and the number and condition of stock hogs on hand for fattening.

The October schedule deals with the average yield per acre and the quality of spring wheat, oats, barley, rye, and hops, and the condition of corn, potatoes, sugar cane, tobacco, rice, and apples.

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The November schedule deals with the average yield per acre of corn, buckwheat, potatoes, hay, tobacco, and rice.

The December schedule deals with the production and farm prices of all the principal crops, and the acreage of winter wheat and rye sown for the crop of the following year, and also with the condition of winter wheat and rye.

The individual farm schedule sent out in October deals with the acreage and production of the principal crops on about 100,000 individual farms and is used as a check on the reports from regular correspondents.

Special cotton schedules are sent out each month during the growing season. The May schedule deals with the acreage and condition of cotton. The June, July, and September schedules deal exclusively with the condition of cotton. The August schedule deals with the condition of cotton and the amount of old cotton on hand. The November schedule deals with the average yield per acre of cotton, the abandoned acreage, if any, and the cost of picking.

METHODS OF HANDLING REPORTS.

Just previous to the issuing of the monthly reports, the several different corps of correspondents send their reports separately and distinctly to the Department at Washington.

The reports of special field agents and State statistical agents residing at points more than 500 miles distant from Washington are sent by telegraph, in cipher, to the Secretary of Agriculture, by whom they are placed in a safe located in his private office, to which there is no access until the day on which the report is issued.

In order to prevent any possible access to reports which relate to speculative crops, and to render it absolutely impossible for premature information to be derived from them, all of the reports from the State statistical agents, as well as those of the special field agents relating thereto, are sent to the Secretary of Agriculture in specially prepared envelopes addressed in red ink with the letter "A" plainly marked on the ends. By an arrangement with the postal authorities, these envelopes are delivered to the Secretary of Agriculture in sealed mail pouches. These pouches are opened only by the Secretary or Assistant Secretary, and the reports, with seals unbroken, immediately placed in the safe in the Secretary's Office, where they remain sealed until the morning of the day on which the reports are issued, when they are delivered to the Statistician by the Secretary or the Assistant Secretary. The combination for opening the safe in which such documents are kept is known only to the Secretary and the Assistant Secretary of Agriculture.

Reports from the State statistical agents and special field service in relation to nonspeculative crops are sent in similar red, addressed envelopes, marked "B," which go to the Bureau of Statistics and are kept secured in a safe until the data contained in them are used by the Statistician in computing estimates regarding the crops to which they relate. The reports from the county correspondents, township correspondents, and other voluntary agents are sent to the Chief of the Bureau of Statistics by mail in sealed envelopes. The figures reported are transferred from the schedules to large tabulating sheets, where they are given proper arithmetical weight, according

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to the acreage or production of the county or agricultural unit they represent. State averages are then determined and the computations verified. All these reports are tabulated in separate sections working in separate rooms, and, to guard against any individual drawing deductions from the results shown for any State or States tabulated by him, the chief of the division numbers the tabulation sheets at the top, where the name of the State to which they relate appears, and cuts off and omits groups of counties marked with the number, so that there is nothing to show the State to which any figures pertain. After having been worked up by different clerks in other rooms from those in which they are tabulated and partially added, they are delivered by the chief of the division to the Statistician, who assembles the sheets for final computation.

METHODS OF PREPARING REPORTS.

For the purpose of checking up the results of the several sources of information and reducing the possibility of error to a minimum, the final results are made up by a crop-reporting board, composed of the Chief Statistician or Chief of the Bureau of Statistics, as chairman, and four individual members, made up of statisticians and officials in the Bureau and members of the special field service, called to Washington on report days for that purpose. Thus the plan is to select four members of this board each report day from an available corps of six or eight men well trained and thoroughly informed as to crop conditions and as to the relative value and correctness of the reports from the different corps of correspondents. This board, with several expert computers, meets on report days in the office of the Statistician, which is kept locked, no one being allowed to enter or leave it. All telephones are disconnected.

After the assembling of the board, all reports by States from the several distinct corps of correspondents are brought together in convenient form in parallel columns on final tabulation slips, and the board is thus provided with several separate estimates covering the same territory and the same crops, made by the respective corps of correspondents, each reporting for a territory with which he is thoroughly familiar. There are also prepared for the board abstracts of the reports on each crop, by States, from the weekly Weather-Crop Bulletins of the Weather Bureau issued during the month. With all these data before them, each individual member of the board computes separately his own estimate of each crop by States. These reports are then compared and discussed by the board under the supervision of the chairman, and the final figures by States are decided upon. It is interesting to remark how often the reports of the different corps of correspondents are very nearly identical, and how closely the final figures arrived at by the individual members of the board agree. These State estimates, which are in percentages, are then multiplied into the acreages for their respective States; the sums of these products are divided by the sums of the acreages to get the percentages for the entire crops for the United States.

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METHOD OF ISSUING REPORTS.

Reports in relation to cotton thus prepared by the crop-reporting board are issued on the 3d of each month during the growing season, and reports relating to the principal farm crops and live stock are prepared and made public on the 10th day of each month. In order that the information contained in these reports may be made available simultaneously throughout the entire United States, and that one part of the country may not have the advantage over another, they are simultaneously handed, at a given hour, as at 12 o'clock noon or at 4 o'clock p. m. on report days, to all applicants and to the Western Union Telegraph Company and the Postal Telegraph-Cable Company for transmission to the exchanges and to the press. These companies have reserved their lines at the designated time, and forward immediately the figures of most interest. A mimeograph statement, also containing such estimates of condition or actual production, together with the corresponding estimates of former years for comparative purposes, is prepared and sent to a mailing list of exchanges, newspaper publications, and individuals. The same afternoon printed cards containing the essential facts concerning the most important crops of the report are mailed to the 77,000 post-offices throughout the United States for public display, thus placing the most valuable information within the farmer's immediate reach.

Promptly after the issuing of the report, it, together with other statistical information of value to the farmer and the country at large, is published in the Crop Reporter, an eight-page publication of the Bureau of Statistics, under the authority of the Secretary of Agriculture. An edition of over 100,000 of this Reporter is distributed to the correspondents and other interested parties throughout the United States each month.

WORK OF THE YEAR.

CHANGE IN METHODS.

A crop-reporting board, composed of a chairman and four members, as already noted, has been appointed, with entire jurisdiction over all crop reports and estimates made by the Bureau.

Thus, when the final results obtained from the several corps of correspondents are assembled on report days, the Department's figures are determined by employing the judgment of several experts instead of a single individual. This has been generally accepted as a marked improvement in the crop-reporting service. The Weather-Crop Bulletins of the Weather Bureau are also used by the Bureau in the preparation of its estimates.

A very great improvement has been made in the special field service by districting the United States and assigning each of the respective field agents to a definite group of States, which they thoroughly travel over and report on each month. The cotton-producing States have thus been redistricted and the service augmented and perfected there by the appointment of two new agents, Mr. P. L. Hutchinson, of Georgia, and Mr. F. N. Gray, of Texas. These men are widely recognized as men with thorough knowledge of conditions and of the highest ability and integrity. Mr. J. H. Killebrew, of Tennessee,

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has recently been appointed a special agent for the collection of statistics of tobacco, and has entered upon his duties, which are to supplement the reports from the Bureau correspondents by actual observation in the field. The work of the State statistical agents is also being improved.

Working in harmony and cooperation with the Census Bureau of the Department of Commerce of Labor, the compilation of statistics of the commercial cotton crop has been transferred to the Census Office.

PUBLICATIONS PREPARED AND ISSUED BY THE BUREAU OF STATISTICS.

In addition to the work of estimating crop conditions, the acreage, production, and value of the principal cereal products, and the number and value of farm animals, a considerable amount of work is done by this Bureau in special statistical investigations and in the preparation of special bulletins and of papers for publication in the Yearbook; also in making short investigations to obtain information necessary to answer inquiries of news correspondents, and to secure data for the use of Senators, Representatives, and officials of this Department.

During the past year there were issued monthly editions of the Crop Reporter of over 100,000 copies each, and bulletins, circulars, and reprints, as follows:

BULLETINS.

No. 28. The Commercial Cotton Crops of 1900–1901, 1901–2, and 1902–3. By James L. Watkins. July, 1904.

No. 29. Methods and Routes for Exporting Farm Products. By Edward G. Ward, jr., Expert in Transportation Statistics. October, 1904.

No. 30. International Sugar Situation. Origin of the Sugar Problem and Present Aspects under the Brussels Convention. By Frank R. Rutter, Assistant Chief, Division of Foreign Markets. December, 1904.

No. 31. Imports of Farm and Forest Products, 1901–1903, by Countries from which Consigned. Compiled by the Division of Foreign Markets. March, 1905.

No. 32. Exports of Farm and Forest Products, 1901–1903, by Countries to which Consigned. Compiled by the Division of Foreign Markets. April, 1905.

No. 33. Trade with Noncontiguous Possessions in Farm and Forest Products, 1901–1903. Compiled by the Division of Foreign Markets. May, 1905.

No. 34. The Commercial Cotton Crop of 1903–4. By James L. Watkins. September, 1905.

No. 37. Trade with Noncontiguous Possessions in Farm and Forest Products, 1902–1904. Compiled by the Division of Foreign Markets. October, 1905.

CIRCULARS.

No. 16. Foreign Trade in Farm and Forest Products, 1904. By George K. Holmes, Chief of Division of Foreign Markets. March, 1905.

REPRINTS OF PAPERS FROM YEARBOOK OF 1904.

The Castor Oil Industry. By Charles M. Daugherty, of the Bureau of Statistics. June, 1905.

Consumers' Fancies. By George K. Holmes, Chief of the Division of Foreign Markets, Bureau of Statistics. June, 1905.

Statistical Matter Relating to Principal Crops and Farm Animals, Freight Rates, Exports, etc., of the United States, 1904. June, 1905.

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STATISTICS OF FOREIGN MARKETS.

During the past year the Division of Foreign Markets of this Bureau has been occupied in the consideration of a large number of subjects pertaining to the exportation of our National agricultural surplus.

COTTON.

The leading export product is cotton, and, in view of this fact, a thorough examination has been given to the hundreds of assertions published within a year or two in many places throughout the world that new and permanent fields of cotton production had been exploited and were about to become large producers of cotton. The organized efforts of powerful associations of cotton manufacturers in Great Britain, Germany, and France to establish and stimulate cotton production in the colonies of these countries, which began early in 1903 with a large capital subscribed for promotion, have so far resulted in no perceptible addition to the world's cotton crop, and there are no present indications of a competition of new fields of production which will materially affect the foreign market for the upland cotton of this country for many years.

MEAT.

It is desirable that the cattle growing and slaughtering interests of this country should acquire more definite and comprehensive information than they have had before concerning the packing-house exports from this country and, on the other hand, concerning the imports of such products by European countries from various contributing regions, among which the United States finds as competitors Argentina, Canada, Australia, Russia, and minor countries. This Division has been intrusted with acquiring this information, and at the date of this report has nearly completed its collection and arrangement for publication. The scope of this information makes the undertaking a large one, embracing, as it does, a statement of the exports of live meat animals and of all ascertainable packing-house products from the United States during the last fifteen years to thirteen European countries and Cuba, the various customs regulations pertaining to these laws, and the inspection required by law before the commodities can be admitted to consumption.

WHEAT.

The public was far too ready to conclude last year that the United States had lost its wheat surplus, the sole reason for such conclusion being a short crop. The situation of many preceding years has been restored by this country's bountiful crop of 1905, the amount of which has been computed to be nearly 700,000,000 bushels. Out of this quantity, the domestic consumption, including the requirements for seed, upon the basis of the statistics of the last three years, will somewhat exceed 500,000,000 bushels, so that the national surplus of wheat, including flour at its equivalent in wheat, may be expected to approach 200,000,000 bushels by the end of the fiscal year 1906.

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CORN.

Out of the corn crop of 1905 may be expected a generous surplus for export, either in corn or its manufactured products, or in beef and other packing-house products. An assured crop of over 2,700,000,000 bushels, or a crop greater than ever before harvested, worth on the farm approximately $1,000,000,000, promises an immense contribution to this country's export trade during the fiscal year 1906.

RICE.

During the past several years the production of rice has been so greatly increased, in part by the work of this Department, that a portion of some crops now enters our exports in substantial quantities, and the rice producer finds himself more acutely than ever interested in the world's product of the rice crop. Our home consumption is being rapidly increased, but there continues a considerable importation during most years under the existing tariff, especially of the lower classes of rice and rice products, part of which is used in brewing.

CEREALS IN EUROPE.

More than two-thirds of the surplus cereal production of the United States is marketed in Europe. Countries of western Europe which have grown to depend largely on imported grain are contemplating measures with the object of substituting more largely the product of their own agriculture. In order to measure as accurately as possible how far each country is a buyer or a seller of grain and whether its production or its consumption is increasing with greater rapidity, the Division of Foreign Markets has continued former work on a comprehensive comparison of the agricultural and commercial statistics of the various European countries. Of all competitors of the United States in wheat production, Russia is by far the most formidable. The conditions, methods, and cost of wheat production in that country have consequently been made a subject of more detailed study.

INTERNATIONAL SUGAR SITUATION.

The investigation made by the Division of Foreign Markets into the international sugar situation was completed during the fiscal year and published as Bulletin No. 30 of the Bureau of Statistics. Issued one year after the Brussels Sugar Convention went into effect, the bulletin indicated the important changes that followed the signing of that instrument.

EXPORT ROUTES.

The routes by which surplus crops find their way from United States farms to European consumers have received attention during the year. These are determined to a large degree by differences in freight charges. Ports once the leaders in the export trade in a certain product are in time surpassed by other ports which have gained better advantages for obtaining and exporting the product in question.

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FREIGHT CHARGES.

The cost of carrying farm products, especially grain, from the United States to Europe is comparatively small. The charges incident to shipping products from farms to the seaboard constitute the largest part of the cost of transportation in the export trade, the freight rate on grain from the Missouri River to New York being often as much as five times the ocean rate from New York to Liverpool. To estimate the entire cost of sending a given consignment from the interior of the United States to a point in Europe, charges for such items as transfer, storage, inspection, weighing, and insurance should be added to inland and ocean freights.

Railroad freight rates and the minor charges connected with storage, transfer, and insurance are not subject to such frequent fluctuations as are ocean freight charges. For this reason, in compiling data concerning cost of transportation of exports, tables of ocean freight rates are of special importance, and a large amount of information has been collected.

PORT FACILITIES.

The subject of port facilities also has had attention. The United States has altogether twenty or more important seaports, located at convenient intervals along the Alantic, Gulf, and Pacific coasts, and all well equipped for handling a large foreign trade. A considerable amount of information concerning the size and capacity of railroad yards at various ports, extent and character of wharves and warehouses, number and capacity of grain elevators, and origin of principal freight has been furnished to the Division of Foreign Markets by railroad companies. Other data concerning port facilities have been obtained from various official and commercial sources by means of visits made by persons connected with this Bureau to some of the seaports.

COOPERATIVE WORK FOR OTHER BUREAUS AND DIVISIONS.

During the year there has been harmonious cooperation between this Bureau and the other Bureaus, Divisions, and Offices of the Department. The statistical work pertaining to many of the investigations and appearing in various publications of the different branches of the Department of Agriculture is largely done by the expert compilers and computers in the Bureau of Statistics, and such statistical work as is not prepared by this Bureau is carefully revised by the statisticians and given approval before publication.

COST OF PRODUCING FARM PRODUCTS.

On January 1, 1902, the Department of Agriculture, in cooperation with the Minnesota Experiment Station, began statistical investigations to determine the cost of product per acre of each of the principal farm crops, the cost of each operation in such production, also the cost of live-stock products.

The method of procedure has been to keep a labor and financial account with about twenty-five farms. There are three routes in

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widely separated agricultural regions of the State. Each farm is visited each day and an accurate record taken, showing the number of hours worked by men and horses in each field, in connection with each crop or with each group of live stock or other enterprise on the farm, and also the cost of keeping hired men and the cost of keeping work horses. From the records kept it has been possible to estimate also the depreciation in value of farm machinery, the farm, the rental value of land, cost of binding twine, seed, etc. An accurate estimate is thus secured of the complete cost to the farmer of producing each crop and of each operation in crop production and in the care of live stock. Progress has been made also in devising simple systems of recording farm accounts and of farm bookkeeping. The results of this work promise to be of great value in courses of instruction in farm management in the agricultural schools. It is hoped that the methods now well developed in this new line of investigation may be employed in other States. This work is sufficiently advanced to admit of the publication of results at an early date. It is thought that the data thus secured will prove of great value in solving questions of farm management and various other problems that confront the modern farmer.

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REPORT OF THE LIBRARIAN.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
Washington, D. C., September 1, 1905.

SIR: I have the honor to submit herewith the executive report of the Library for the fiscal year ended June 30, 1905.

Respectfully,

JOSEPHINE A. CLARK,
Librarian.

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

ADDITIONS TO THE LIBRARY.

For a number of years the books added to the Library have averaged about 4,000 volumes. The past fiscal year has maintained this rate of increase, bringing the present collection of works and pamphlets up to 87,000 in number. The publications of other Departments of the Government, which form a separate collection in the Library, are not included in this enumeration. Among the important accessions have been a number of valuable works on entomology, which have placed this special collection in the first rank. A catalogue of this collection is referred to among the publications of the Library for the past year. A large number of gifts have been received from numerous sources, but most largely from foreign governments and from scientific societies in all parts of the world. These contributions to the Library are among its most valuable and useful accessions.

CATALOGUING.

The number of cards added to the general catalogue the past year has exceeded that of any previous year. About 20,000 cards, including those prepared in the Library and those obtained from the Library of Congress, the American Library Association Publishing Board, and the Torrey Botanical Club, have been added to the catalogue. The purchase of all available printed cards for publications in the Library and for publications in other government libraries which may be available for use in the Department has proved to be most advantageous in the saving of time and expense, in addition to the convenience experienced in having this information currently incorporated in the catalogue.

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The third contribution to the printed subject catalogue of the Library, comprising works on entomology, has been completed. This special collection is one of the largest in the Library and has but one, if any, rival in the country. It contains the principal works published on systematic entomology, including many valuable illustrated publications of ancient and modern dates, together with a very large number of publications relating to economic entomology. The catalogue will serve as a supplement to the existing bibliographies of entomology of earlier dates.

In addition to the usefulness of this volume to the entomologists of the Department, it will be of great service to those in the agricultural colleges and experiment stations and to individual scientists throughout the country.

PERIODICALS.

Every year the list of this class of additions to the Library lengthens. To the last year's list have been added 175 new titles. In recent years the number of new magazines relating to gardening alone has increased considerably. The rapid progress in agricultural and scientific investigations necessitates the multiplication of journals, especially those of a technical character. To acquire files of all the leading periodicals of service in the work of the Department and of agricultural papers which can not be preserved in general public libraries to any extent, is one of the principal functions of the Library. There are received at present 3,819 agricultural papers and periodicals and technical publications, of which number 529 are purchased and 3,290 are received as gifts or in exchange for publications of the Department. Through the courtesy of publishers, especially of agricultural papers, for which a subscription is rarely asked, the greater number of the American periodicals are received gratis. Such favors are frequently reciprocated by the sending of Department publications. The receipt, stamping, recording, and filing for reference and, later, the binding of thousands of separate numbers annually received constitutes one of the most important branches of the Library work. The edition of the Catalogue of Periodicals and other Serial Publications in the Department Library issued in 1900 is out of print and a new edition with the additions to this class during the past five years is in preparation. The usefulness of this publication is not confined to the Department, as the catalogue is also used as a check list in large libraries throughout the country.

BINDING.

The collation of technical periodicals for binding requires special attention to details, which is time-consuming and yet necessary for the future usefulness of the volumes. The greater number of works annually prepared for binding in the Library are of this character; therefore the increase in the number of volumes bound from year to year will not change materially until two assistants at least can be regularly employed in the work. Thus far even one assistant has not been constantly employed on this work on account of temporary needs of the service in other departments of the Library. The number of

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volumes bound the past year was 1,942, an increase of 235 as compared with the previous year.

Scientific literature is so largely published in serial and pamphlet form and in paper-bound volumes that the needs of the Library for binding its accessions continually exceed the provisions made for them from year to year.

LIBRARY PUBLICATIONS.

The quarterly bulletin entitled "Accessions to the Department Library" and index cards for Department publications have been continued during the past year. The distribution of these cards is principally to the large libraries which receive regularly the publications of the Department. The number of institutions receiving partial or complete sets of the index cards is 403. Since the cards for the Yearbooks and Farmers' Bulletins have been issued separately 57 small libraries have availed themselves of these cards. During the past year 1,076,400 index cards have been printed and, with the exception of a small reserve, have been distributed in five issues, varying from 219 to 858 cards in each issue. This card index of the Department publications is not only a great convenience in connection with Department work, but is valued by all libraries receiving publications from us. A list of the publications thus far indexed is given below:

Yearbooks 1894–1903.
Farmers' Bulletins 1–206.
Reports 1–32, 34–72.
Miscellaneous special reports 1–10.
Special reports 1, 3, 4, 11, 12, 18, 22, 26, 28, 31, 33–36, 40, 47, 48, 50, 54, 55, 62, 63.
Bureau of Plant Industry: Bulletins 1–50.
Division of Accounts: [Special reports] 1894–1898.
Division of Agrostology: Bulletins 1–24; Circulars 1–36.
Division of Botany: Bulletins 1–29; Circulars 1–30; Contributions from the United States National Herbarium, vols. 1–7.
Division of Pomology: Bulletins 1–10; Circulars 1–3; Nut culture; Reports of the Pomologist 1886–1900.
Division of Soils: Bulletins 1–16; Circulars 1–7.
Office of Fiber Investigations: Annual Reports 1890–1897; Reports 1–11; United States Flax and Hemp Commission Report.
Office of Public Roads Inquiries: Bulletins 1–26; Circulars 14–36; Reports of Director 1893–1902.
Section of Seed and Plant Introduction: Inventories 1–8; Circulars 1–2.
Bureau of Entomology: Bulletins 1–33, new series 1–43, technical series 1–9; Annual Reports 1863–1903; Bibliography of American Economic Entomology, pts. 1–7; Circulars, series 2, 1–55; 3 miscellaneous reports; U. S. Entomological Commission, Reports 1–5; Bulletins 1–7.
Office of Experiment Stations: Bulletins 1–140; Miscellaneous Bulletins 1–3; Circulars 1–4, 6–8, 11–13, 17–58.
Bureau of Chemistry: Bulletins 1–80; Circulars 1–18; Reports 1862, 1864–1903.

INDEXING AGRICULTURAL LITERATURE.

The announcement in the last annual report of the proposed cooperation with the Library of Congress for the printing and sale of catalogue cards for important agricultural periodicals has been carried into effect during the year. Cards prepared by the Library

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have been printed and sold by the Library of Congress to 29 subscribers for the following periodicals, covering the dates given: Annales de la Science Agronomique, 1884–1904; Die Landwirtschaftlichen Versuchsstationen, 1859–1904, and Landwirtschaftliche Jahrbücher, 1872–1904.

Cards are available for purchase in complete sets for each or for all these publications; also, any number of cards for any subject covered by these periodicals can be obtained. An opportunity is thus afforded agricultural colleges and experiment stations, as well as individual scientists, to procure at a small cost index cards relating to agricultural science. It is expected that additional periodicals will be indexed each year and that the list of subscribers will increase as the work becomes more widely known.

RECOMMENDATIONS.

The most pressing needs of the Library at present are for more space for its yearly additions and for a larger appropriation, the latter to provide especially for the binding of a larger number of volumes annually, in addition to the usual requirements for the purchase of books. As new lines of work are taken up by the Department the Library is called upon to supply all needed data for carrying them on to the best advantage. To meet these demands at all satisfactorily, and thereby further the general and new lines of work of the Department, the appropriation for the general expenses of the Library must be increased proportionately.

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REPORT OF THE DIRECTOR OF THE OFFICE OF PUBLIC ROADS.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS,
Washington, D. C., September 29, 1905.

SIR: I have the honor to submit herewith the report of the Office of Public Roads for the fiscal year ending June 30, 1905, together with an outline of the work for the current year and recommendations and estimates for the ensuing year.

Respectfully,

LOGAN WALLER PAGE, *Director.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR.

During the greater part of the fiscal year 1904–5 the work of the Office was carried on along established lines. The building of object-lesson roads was considerably increased, and other branches of the work were somewhat curtailed in order to make this possible.

During the latter part of the year a reorganization was begun which involved marked changes in the scope of the work and the method of procedure. This reorganization was at first tentative in its character, excepting the collection of information in regard to the economics of road improvement, a branch of the work which was gotten well under way before the close of the fiscal year, and much important information was collected.

Pending the consolidation of the Division of Tests of the Bureau of Chemistry with this Office on July 1, 1905, cooperation was maintained with that division, laboratory tests being made of many of the road materials used in the construction of object-lesson roads built under the direction of this Office.

OBJECT-LESSON ROADS.

This branch of the work was continued along lines previously followed, except that a more complete and accurate record was kept of each road built. While the plan of procedure was not materially changed, every effort was directed toward increasing the amount of work done within the year. Accordingly, four complete crews and outfits—composed of one road expert, one machinery expert, and a full complement of modern road-making machinery—were placed in the field at the beginning of the season and continued without interruption throughout the fiscal year.

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The terms and conditions under which this assistance was granted were as follows: This Office furnished expert supervision, supplied all necessary modern road-making machinery, and provided for the testing of road materials in the laboratory at Washington. The local communities were required to furnish all materials, common labor, teams, fuel, etc., needed in the construction of the road.

Twenty-one roads were built in 9 different States, representing a wide diversity in character of construction and kind of material used. The following detailed reports show that granite, limestone, trap, shale, burnt clay, sand clay, flint, sandstone, oyster shells, clam shells, novaculite, gravel, chert, and marl were used in the construction of these roads. The total length of the 21 object-lesson roads was a little over 9 miles. At many of the places where work was carried on a complete outfit of machinery, consisting of steam roller, crushing plant, road grader, sprinkler, dump wagons, scrapers, plows, etc., was used. At Gainesville and Tallahassee, Fla., where sand-clay roads were built, only road graders, wagons, scrapers, etc., were necessary.

The reports show a maximum cost of 98 cents and an average cost of 55 cents per square yard for macadam roads, and an average cost of 9½ cents per square yard for sand-clay roads. The cost of the one burnt-clay road constructed is shown to be 20 cents per square yard, and of the one shell road, 34 cents per square yard. The wide difference in the cost of the macadam roads is due to the difference in cost of labor and teams, the amount of grading, the culverts built, the length of haul of materials, and the general efficiency or inefficiency of the labor employed.

CHAGRIN FALLS, OHIO.—This road, located near the town of Chagrin Falls, was begun July 30 and completed August 29, 1904. The character of construction was macadam, the material used being sandstone for the foundation and crushed granite bowlders secured from fields near the work for the surface. The dimensions of the road were as follows: Length, 2,400 feet; width, 9 to 13 feet; depth, 10 to 12 inches. The cost per square yard was about 80 cents.

COLUMBUS, OHIO.—This road, located on the ground of the State University, was begun the 1st of October and was practically completed the last of November, 1904. The character of construction was macadam. The foundation course consisted of brickbats from a burned building, which were crushed and rolled by the steam roller, and the surface composed of crushed granite bowlders gathered from fields around Columbus. The dimensions of the road were as follows: Length, 835 feet; width, 18 feet; depth, crushed rock, 6 inches, with a foundation of crushed bricks 4 inches deep. The total cost was $1,629.64, which includes $228.55 for grading and $849.78 for 466 tons of granite bowlders, at $1.45 per ton. The cost per square yard was 97 cents.

COSHOCTON, OHIO.—Work was begun on this road in November, 1904, and continued until the early part of December, when operations were suspended on account of adverse weather. In May, 1905, the work was resumed but was not completed at the end of the fiscal year. The character of construction was gravel macadam, the material used being sandstone for the foundation and crushed gravel for the surface. The dimensions were: Width of macadam, 9 feet; total width of road, 24 feet; depth of material, 10 inches. The length of finished road and total cost will be given in the next annual report.

DEKALB, ILL.—This road, an extension of South First street, one of the main highways leading into the town, was begun the latter part of July and completed about the 1st of October, 1904. The character of construction was macadam, the material used being limestone, shipped from Oak Ridge, nearly 100 miles distant. The dimensions of the road were as follows: Length, 4,510 feet; width, 12 feet; depth, 8 inches. The total cost of this road was

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$5,920.42, of which amount $2,642 was for material and $3,278.42 for labor. Of the amount paid for labor, $1,334 was paid for grading. The cost of crushed stone per cubic yard f. o. b. Dekalb was $1.15; the cost per square yard of road surface was therefore 98 cents.

LEBANON, Mo.—This road, located on the Hartville road, 1½ miles from Lebanon, was begun about the 1st of October, and completed in thirty-eight days. The character of construction was macadam, the material used being novaculite or chert from fields near the work. The dimensions of the road were as follows: Length, 2,950 feet; width of macadam, 9 feet; depth, 11 inches. The total cost was $987, making the cost per square yard 33 cents.

SPRINGFIELD, Mo.—This road, known as the Cherry Street road, extends west from the Government boulevard and the southeast limits of the city of Springfield, in Greene County. The work was begun about the 1st of November, 1904, and completed in twenty-three days. The character of construction was macadam, the material used being novaculite or chert from a field 2½ miles from the road. The dimensions of the road were as follows: Length, 1,310 feet; width of macadam, 16 feet; thickness, 9 inches; total width of road, 24 feet. The total amount of material used was 672 cubic yards, and the total cost of the road was $780, making the cost per square yard of surface 33 cents.

NEOSHO, Mo.—This road, called the Seneca road, beginning at the city limits and extending one-half mile to the west in Newton County, was begun November 19 and completed December 31, 1904. The character of construction was macadam, the material used being novaculite or chert gathered from fields near the road. The dimensions of the road were as follows: Length, 2,640 feet; width, 12 feet; depth, 7 inches. The cost, including labor, teams, culverts, fuel, and incidentals, was $1,529.11, of which amount $408.25 was for culverts. The cost per square yard was therefore 43 cents.

ARKANSAS CITY, KANS.—This road, located in Cowley County and known as the Walnut street road, was begun December 8, 1904, and completed January 26, 1905. The character of construction was macadam, the material used being limestone quarried and crushed at the end of the road near Walnut River bridge. The dimensions of the road were as follows: Length, 3,615 feet; width of macadam, 14 feet, and depth, 10 inches. The amount of stone used was 1,600 cubic yards. The total cost, including blasting, quarrying, crushing, and hauling, teams, labor, and incidentals, was $2,223.98, making the cost per square yard 39 cents.

BELLINGHAM, WASH.—This road was begun September 2 and completed October 18, 1904. The character of construction was macadam, the material used being 894 cubic yards of granite bowlders, shipped from Sand Creek Mountain. The dimensions of the road were as follows: Length, 2,050 feet; width, 15 feet; depth, 8 inches. The total cost of the road, including quarrying, crushing, transportation of material, fuel, oil, etc., was $2,683.86. Of this amount $285.26 was paid for grading, ditches, and culverts. This cost is based on labor at $2 per eight-hour day and $5 per day for man and team. The cost per square yard was 78 cents.

WALLA WALLA, WASH.—This road was begun October 24 and completed November 29, 1904. The character of construction was macadam, the material used consisting of 400 cubic yards of trap rock hauled 13 miles by rail. The dimensions of the road were as follows: Length, 2,048 feet; width, 18 feet; depth, 8 inches. The total cost, including grading, material, hauling, crushing, spreading, and transportation of material at 38 cents per cubic yard, was $1,701.84, of which amount $185 was paid for grading and ditching and $277 for transportation of material. The cost of teams was $3 per day and of labor $1.50 per day. The cost per square yard was 41 cents.

BEAUMONT, TEX.—This road, constructed along Grand avenue, beginning at Magnolia avenue, was begun September 27 and completed November 11, 1904. The material used was small unwashed clam shells brought to Beaumont by boat 28 miles. The dimensions of the road were as follows: Length, 3,154 feet; width, 16 feet; depth, 7 inches; width of roadway, 40 feet. The only labor used was that of city and county prisoners. The total cost of material was $5,712.30, being at the rate of $2.15 per cubic yard.

SHREVEPORT, LA.—This road, located outside the city limits of Shreveport, in Caddo Parish, and known as the Fairfield road, was begun about the 1st of

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July and completed about the middle of September, 1904. The character of construction was gravel, the material being transported by railroad from pits near Sibley, La., a distance of more than 32 miles. The length of the road was 3,306 feet, and the width 16 feet. The total cost was $1,962.28, or 33 cents per square yard.

JACKSONVILLE, FLA.—This road was begun January 11 and completed April 22, 1905. The character of construction was macadam, the material used being 1,727 tons of marl shipped by rail from Macon, Ga., a distance of 250 miles. The dimensions of the road were as follows: Length, 5,280 feet; width, 15 feet; depth, 6 inches. The cost of grading and draining was $931, and the total cost $5,211.03. The cost of labor was at the rates of $1 and $1.25 per day, and teams cost at the rate of $3 for an eight-hour day. The cost per square yard was 59 cents.

GAINESVILLE, FLA.—At this place two object-lesson roads were constructed, of which the following is a brief description:

Road No. 1.—This road, leading from North Gainesville to Paradise, was begun February 14 and completed March 18, 1905. The character of construction was sand-clay, the material having been secured about 1 mile from the road. The dimensions were as follows: Length, 1 mile; width, 14 feet; average depth, 9 inches. The cost of labor was at the rate of $1 per day, and of teams at the rate of $3 per day. The total cost was $881.25, and the cost per square yard, 10 cents.

Road No. 2.—This road, located on East Main street, was begun March 14 and completed March 29, 1905. The character of construction was macadam, the material used being 750 tons of flint rock procured 5 or 6 miles from Gainesville and hauled by wagons. The dimensions of the road were as follows: Length, 265 feet; width, 70 feet. The total cost was $572.31, of which amount $476.95 was for teams and labor on the basis of $1 for day laborers and $3 per team. The cost per square yard was 23 cents.

PENSACOLA, FLA.—Two roads were constructed at this place.

Road No. 1.—This road, located on West Romaine street, was begun April 24 and completed May 8, 1905. The character of construction was macadam, the material used being approximately 450 tons of granite mixed with trap rock and shale, all of which was brought from Germany as ballast. The dimensions of the road were as follows: Length, 506 feet; width, 32 feet; depth, 6 inches. The cost of labor was at the rate of $1.25, and teams at $4 per day of ten hours. The total cost was $771.60. The cost per square yard was 42 cents.

Road No. 2.—This road, located on East Gladston street, was built at this place to illustrate the sand-clay method. The work was begun April 28 and completed May 5, 1905. The material consisted of sand and clay properly mixed. The dimensions of the road were as follows: Length, 1,800 feet; width, 15 feet; depth, 10 inches at the center and five inches at the sides. The total cost was $419.50, of which amount $222 was paid for moving, installing, and maintaining a convict camp. The cost per square yard was 14 cents.

TALLAHASSEE, FLA.—This road, extending from the Seaboard Railroad station to Capitol square, was of sand-clay construction. The dimensions of the road were as follows: Length, 4,480 feet; width, 16 feet; depth, 7½ inches. The total cost was $440, on the basis of labor at $1 and teams at $3 per day. The cost per square yard was 5 cents.

FERNANDINA, FLA.—This road was begun May 15 and completed May 30, 1905. It was built of shells, and was 1,199 feet long, 24 feet wide, and 6 inches deep. The road had been located and graded before the road experts of this Office arrived. The total cost was $1,113.85; the cost per square yard, 34 cents.

EXPERIMENTAL ROAD.

One of the greatest problems to be solved in connection with road improvement in the United States is to provide suitable materials for road building at a reasonable cost in the vast sections of country where natural hard road materials are not available except at very great expense. Even where materials are procurable, it is frequently the case that the cost of hard roads is beyond the means of the people.

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Accordingly, investigations and experiments have been carried on from time to time by this Office for the purpose of obtaining a substitute for natural hard materials which would make a satisfactory road at a reasonable cost.

The following report on an experimental burnt-clay road at Clarksdale, Miss., as outlined by Mr. W. L. Spoon, expert in charge of the work, is given at some length, together with a later report on the result of the experiment, on account of its important bearing upon the question of road improvement throughout the great Mississippi Delta and the prairie States:

The work was performed September 1 to 10, 1904. The length of road burnt was 300 feet, and the width 12 feet. The cost was as follows:

Wood used, 30½ cords, at $1.30	$39.65
Barks and chips, etc., 20 two-horse loads	6.00
Labor at $1.25 and teams at $3 per day	38.30
Total cost	83.95
Total cost per mile at this rate	1,477.52

Although the road was only burned to a width of 12 feet, it showed a finished surface of nearly 14 feet.

In the preparation of the road for burning it was first plowed up as deep as four mules and a steel plow could break it, from ditch to ditch, a width of 20 feet, after which it was crowned up with a road machine. Then trenches were cut across the road 4 feet apart and about 12 inches deep, the earth being thrown up so as to form ridges between the trenches. Next, on the middle part of the road to a width of 12 feet, a layer of 4-foot sticks of cord wood was placed over each trench, the ends of the sticks resting on the tops of the ridges and the intervening trenches forming flues across the road. Upon this floor of wood was thrown "gumbo" in lumps and clods, so as to form an open layer, only partially covering the wood. On this was placed a second floor of wood, the sticks being laid at right angles to the road and as close together as possible, and being supplemented with small sticks, chips, bark, and brush, to make a tighter floor. On this floor was thrown a layer about 10 inches thick of "gumbo," partly clods and partly pulverized.

Firing was then begun. The fires were started very much as they are in the fires of a brickkiln. The fires were started on the windward side. We found it desirable to burn in sections of 60 feet, 15 flues at a time, as this enabled one person to look after the burning properly and to see that the fires in all the flues advanced at the same rate and burned out evenly.

After being burned and sufficiently cooled to permit working the burnt surface was smoothed down so as to form a proper crown, and the road was opened to travel without adding clay or any other substance. The ridge and the space between the ridges was generally burned and rendered nonplastic.

Under date of March 27, 1905, Maj. T. G. Dabney, chief engineer, Yazoo-Mississippi Delta levee district, writes as follows regarding this road:

Last summer, during my absence, Mr. W. L. Spoon came here by your direction, at my request, to supervise an experiment in burnt "buckshot" for a road metaling. I had arranged to put Mr. Spoon in the hands of Mr. Walter Clark, an influential citizen and planter, who is interested in road improvement.

The experiment was a small one, only $200 being available from the county fund. The extent of road treated was a little less than 300 linear feet, about 12 feet wide. The clay was burnt in situ.

This method has the great advantage of extending the effects of the burning to a considerable depth below the subgrade, thus giving a more secure foundation.

The experiment was made in crude fashion, as after the burning process the roadbed was neither surfaced nor rolled, but left in a rough state. During the dry fall months the travel avoided this rough piece of road, but when the adjacent ground was softened by the winter rains the wagons took to the burnt

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clay readily and soon packed it down to the semblance of a road, albeit with much inequality of surface. It was used all the winter and stood the traffic perfectly and is a very good road now.

The county at the same time graveled some three-fourths of a mile of road adjoining this, the same that was shaped up by the "good roads train." The gravel is showing signs of deterioration from lack of attention. The burnt clay favorably compares with the gravel, and, as it has a more solid foundation, I regard it as superior.

This experiment, I believe, is going to prove very valuable to this bottom country, and the general adoption of the burnt-clay method will prove to be the solution of the road problem here.

The cost is about one-fourth as much as that of the gravel road, the location of which is especially favorable to minimum cost on account of its facilities for transportation of material by rail.

The burnt-clay road is attracting attention throughout this county and in some of the adjoining counties, and enterprises are on foot for the employment of this method elsewhere.

I am exceedingly gratified to make a favorable report on this experiment, which I believe will lead eventually to great beneficial results in the betterment of the roads in the Mississippi bottoms.

A further report was made by Major Dabney under date of May 5, in which the effect of this work was stated as follows:

The seed sown by Mr. Spoon in the burnt "buckshot" experiment near here last summer bids fair to produce great results. The idea has taken wonderfully with these people, and the county board has appropriated $5,000 to be expended in each supervisor's district this year, $25,000 in all, most of which is to be expended in burnt clay.

The people have asked me to appeal to you again for Mr. Spoon's services, which I hope very much you can respond to favorably. I regard the present movement as exceedingly important, marking a critical epoch in good road evolution in the Mississippi bottom, and it is extremely desirable that it should start off under favorable auspices.

The presence and participation of a Government expert would exert a most favorable influence in getting it started right. If he could devote some attention to each of the five districts in the county he would doubtless inaugurate a good-roads movement that is destined shortly to spread all over the bottom country, which I hope you will regard as important enough to merit your special concern and attention.

The adjoining county of Tunica has caught the infection also and is to do some burnt-clay work this summer.

I suppose that July or August would be the proper time for the work to begin. I am urging these people to begin their preparations at once by getting a supply of wood cut and dried.

EXPERT ADVICE.

In a number of cases where applications were made to the Office for assistance in road improvement, it was found that the building of an object-lesson road was unnecessary, and that it would be sufficient for an engineer or expert to determine the local conditions and give such information and advice as was needed. In the southern territory Mr. W. L. Spoon, road expert in the Office, visited Clarksdale, Miss., previous to the burnt-clay experiments, and Tyler, Selma, and Troy, Ala., to give advice concerning sand-clay and gravel roads. He visited Jacksonville, Gainesville, Tallahassee, Pensacola, and Fernandina, Fla., before beginning object-lesson road work, and gave his opinion where the local authorities were in doubt as to materials and methods of construction. At Ocala, Tampa, Daytona, and Titusville, Fla., he acted in an advisory capacity. In South Carolina Mr. Spoon made all necessary arrangements for work of the Office at Union and Abbeville, and in North Carolina he visited Marion, Rockingham, and Lumberton.

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In the far western territory Mr. James W. Abbott, a special agent of the Office, went to a number of places to give information and advice upon the construction of macadam and oiled roads, and at the same time he investigated mountain-road building. He visited officially during the year Cheyenne, Wyo.; Ogden, Utah; Reno, Nev.; Sacramento, San Francisco, and Los Angeles, Cal.; Roseburg, Eugene, Albany, Salem, and Portland, Oreg.; Walla Walla, Seattle, Bellingham, and Tacoma, Wash.; Boise, Pocatello, Nampa, Emmett, and Caldwell, Idaho; Mesa and Phoenix, Ariz.; Las Vegas, N. Mex., and Ouray, Colo.

J. F. Brown, special agent of the Office, visited a number of places in Ohio and adjoining States officially. Special details of engineers and experts are made from time to time from the Office, but it is hardly thought necessary to make specific mention of all such details here.

Several tours were made by the highway engineer to consult with local communities regarding plans to be followed in future road building and to make necessary arrangements for carrying on the work of the Office during the current fiscal year.

CONVENTIONS.

The assistance given by the Office to road organizations by encouraging road conventions and taking part in such meetings was somewhat curtailed during the year in order that the services of the experts and special agents might be utilized to a greater extent in supervising road-construction work. However, Mr. Martin Dodge, Director of the Office during the period covered by this report, attended and took an active part in the midwinter convention of the National Good Roads Association, at Jacksonville, Fla., in February, 1905, and the annual convention of the same association at Portland, Oreg., in June, 1905. He also participated in the proceedings of the New York and Chicago Road Association at the convention held at Elmira, N. Y., in March, 1905, besides addressing a number of minor conventions in various parts of the country throughout the year.

Lectures and addresses were given by special agents at other meetings and conventions. Mr. R. W. Richardson, special agent, addressed the Trans-Mississippi Congress at St. Louis, October 12, 1904, and on February 1, 1905, he delivered an address at the annual meeting of the National Brick Manufacturers, at Birmingham, Ala. A special lecture, illustrated by stereopticon views, was delivered by Mr. M. O. Eldridge, of the Office, at a number of conventions throughout the country.

The propriety and value of Government participation on a large scale in road-convention proceedings has often been questioned. During my connection with the Office my observation and experience have led me to believe that such participation may be questioned when the main object of the convention or meeting is agitation for the purpose of influencing legislation. Moreover, the results achieved through speeches by Government employees at popular gatherings of this nature can scarcely be considered as having any marked influence upon the progress of road improvement in the United States. There is, however, a field of real usefulness, to be reached only by means of

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speakers and lecturers sent out from the Office. Road organizations serve a useful purpose in arousing the people to a realization of the need for better roads. The problems that are most serious to rural communities, and those which it should be the province of specially equipped employees to explain at meetings of local officers and taxpayers, are *what they need, how to go about getting it, and what their roads will cost.* These speakers should be so well equipped that they could give definite and concise information on which the local communities might act with safety.

Another branch of this work capable of beneficial results is a cooperative system of lectures in engineering schools throughout the country. The demand for skilled highway engineers is already in excess of the supply, and the educational institutions of the country should take prompt and adequate steps to meet the situation. Aside from the engineering features, there are many economic questions involved that should be brought out in lectures to students who intend to devote their lives to highway work.

Much of the work embraced in the scope of the Office is of a scientific and technical nature and involves original thought and investigation. Papers should be prepared and read at the meetings of scientific bodies, and properly qualified members of the Office force should keep in touch with the meetings of organizations having under consideration matters bearing in any way upon the purposes for which the Office was established.

MISCELLANEOUS WORK.

Lantern slides showing various types of roads and methods of road construction were loaned to experiment stations throughout the country and to persons interested in road improvement, for use in illustrating lectures. Many publications of the Office were sent out to all parts of the United States, to the Philippines and to Porto Rico, and to foreign countries.

REORGANIZATION.

Under the act of Congress approved March 3, 1905, the Division of Tests, of the Bureau of Chemistry, and the Office of Public Road Inquiries were consolidated under the name of the Office of Public Roads. The act provided for a statutory roll, and required that the Director of the Office should be a scientist.

In order properly to carry out the provisions of the bill, an entire reorganization of the work became necessary. Accordingly steps were at once taken to provide an adequate plan of reorganization and to inaugurate the necessary preliminary work. As finally determined under the plan of reorganization, the work of the Office was classified as follows: (1) Construction, (2) tests, (3) information, and (4) instruction.

CONSTRUCTION.—This comprises all field construction work in the building of object-lesson and experimental roads and the giving of expert advice on road construction.

TESTS.—This division of the work includes all laboratory investigation of the chemical and physical properties of road materials and materials of construction relating to agriculture.

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INFORMATION.—There is at all times an urgent need for more exact information in regard to the actual status of road improvement in the various States and subdivisions thereof, and especially to the amounts of money expended and the results accomplished by such expenditures. To meet this need organized effort is being made to secure accurate and comprehensive data on all phases of the subject and to make the same available to the public.

INSTRUCTION.—A prominent feature, under the reorganization, is the promotion of highway engineering, not only in schools and colleges throughout the country, but by direct instruction to graduate engineers. Each year a limited number of graduates in engineering are appointed after passing competitive examinations to the position of civil-engineer student. These young men are employed for a period of one year at a small salary, during which time they receive practical training and instruction and render valuable service to the Government. At the end of that period they are eligible for promotion without further examination. This work of instruction to civil-engineer students and the cooperative work with colleges and educational institutions throughout the country are included in this division of the work.

Although the act of Congress did not become effective until July 1, 1905, the plan of reorganization was actually put into effect in a preliminary sense. Dr. Allerton S. Cushman, chemist of the Division of Tests, was made acting chief of that division some months before the close of the fiscal year, pending his appointment as chief of the division and assistant director of this Office on July 1.

A competitive examination was held for the position of highway engineer to be placed in charge of the construction work, which resulted in the appointment of Mr. A. N. Johnson, former highway engineer of the State of Maryland, who entered the service about May 1.

The act of Congress provided for one chief of records on the statutory roll. This work, as laid out, comes under the general class of information. While the facilities for carrying on the work were inadequate, a beginning was made before the end of the last fiscal year in order that there might be no undue delay at the beginning of the present year. Mr. M. O. Eldridge, formerly assistant director of the Office, was assigned to this service and was appointed in June to fill the position of chief of records.

The former system of carrying on office work and administrative details was found to be inadequate to meet the broadened scope of the work involved in the plan of reorganization. The position of chief clerk was created and Mr. J. E. Pennybacker, jr., was appointed to the position. The Office force was accordingly reorganized and placed under the immediate supervision of the chief clerk, and such disposition was made of the force as to provide a larger number of stenographers and to specialize the duties of the various clerks in order that responsibility for work to be done might be fixed and greater efficiency secured. At the same time care was taken that no stenographer or clerk should be assigned exclusively to one official, but by having the entire clerical force of the Office a unit under the direction of the chief clerk the time of each clerk might be utilized to the fullest extent.

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PLANS FOR CURRENT AND FUTURE WORK.

The plans determined upon, following the organization of the Office, comprise wider fields of usefulness in the four general lines or classes of work—construction, tests, information, and instruction.

CONSTRUCTION WORK.

In the construction work assistance will be given as heretofore in supervising the construction of country roads of all kinds and in giving expert advice on every phase of road improvement. This work, which has proved of great practical value, will be enlarged and systematized. A circular of instructions defining object-lesson roads and expert advice within the meaning of the act of Congress, and setting forth the terms under which this Office will grant assistance, is sent out in answer to inquiries on the subject. A blank form application for expert advice and assistance has been prepared, which is required in every instance to be filled out and signed by the local authorities. This application requires those in authority to bind themselves to furnish necessary right of way, and all materials, common labor, teams, fuel, etc., required in the building of the road. Wherever practicable the Office will send engineers and experts to render the assistance asked, and especially to supervise the construction of short sections of model roads, which are rarely more than a mile in length. Complete outfits of road machinery are furnished where this can be done with advantage and without undue expense to the Office.

The construction work will be placed under the management of trained engineers in every instance. These engineers will be assisted by experts thoroughly qualified to operate all road-building machinery that will be required. In each case where an object-lesson or experimental road is built surveys will be made and full information, such as plans, profiles, cross sections, and estimates, will be placed on file in the Office. The engineer in charge of the work will make daily reports on printed forms of the progress made. A strict record will be kept of every item of cost, and formal reports will be made at the beginning and close of the work on each road. In short, no effort will be spared to place the field construction work on a thoroughly systematic and businesslike basis. The aim of the Office will be to secure the highest efficiency in its work, the greatest increase possible in the amount done, and at the same time obtain clear and concise information on every point involved.

There appears to be a growing need for the construction and maintenance of certain roads in the various forest reserves. It is hoped at some time in the near future to extend the field-construction operations of the Office so as to include this work, and also the construction and maintenance of roads on areas other than forest reserves, now under Government control, or which may come under such control hereafter. Such work, however, if it should be undertaken, will require a special appropriation. Plans have already been made for supervising the building of a macadam road on the grounds of the Weather Bureau station at Mount Weather, Va.

Heretofore, in the road building of the Office, machinery has been borrowed from the manufacturers, and this machinery has been

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loaned willingly for object-lesson work. Free transportation for men and machinery has usually been secured from the railroad companies, who base their cooperation on the ground that improved highways are of direct benefit to them. It is believed, however, that the practice of borrowing machinery and of depending upon free transportation is not a wise policy. Gratuitous assistance inevitably tends to hamper freedom of action on the part of the beneficiary which is essential to the proper performance of the work intrusted to public officials. A plan for leasing machinery at a certain per cent per annum of the list price is being favorably considered, and if the recommendation for an additional appropriation to provide for this arrangement is granted, it is probable that ten outfits of machinery will be secured in this manner and placed in the field in charge of engineers and experts. All the details of the plan have been carefully worked out, and it has been found that the arrangement is perfectly feasible and that the machinery can be secured at a fair and reasonable rental. Should the recommendation in regard to an appropriation to cover freight charges meet with approval the old practice of free transportation will be abolished.

In addition to object-lesson roads, it is proposed to conduct, wherever practicable, investigations of special methods of road construction and maintenance. A series of extensive and systematic experiments in the use of oil and coal tar on different road surfaces has already been arranged to be carried out at Jackson, Tenn. With the exception of the results obtained in California there is at present little known concerning the use of oil on roads. The experimental work already begun in the burning of clay in sections of the country where no hard materials are available will be continued. The experimental field work is closely allied to that carried on in the laboratory of the Office.

TESTING MATERIALS.

The work of the Division of Tests falls naturally under the following heads and will be continued as heretofore and each line of work developed wherever it can be done to advantage:

I. Routine tests:
   (1) Rocks for macadam-road building.
   (2) Clays for burnt-clay roads, for drains, and for paving bricks.
   (3) Stone for building and other structural purposes.
   (4) Sands, mortars, cements, and concretes.
   (5) Materials for municipal street paving—brick, wood block, tar, asphalt, oil, etc.

II. Special tests and investigations:
   (1) Cement, concrete, fence posts.
   (2) The corrosion of iron and steel wire fencing.
   (3) The decomposition of rock dust under the action of water, with especial reference to the cause and possible improvement of the binding quality (cementing value) of road materials.

III. The standardization of methods of testing and analyzing materials used in road building and street paving.
   (1) The abrasion test.
   (2) The impact test.
   (3) The cementation test.
   (4) Methods of asphalt analysis.

IV. Machine design and the work of the machine shop:
   Making and repairing instruments for the Department.

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The machine shop of the Division of Tests is already available for making and repairing instruments for the entire Department. It is believed that a further extension of this work will be of great value. The cooperation between the Office and other Departments of the Government service is steadily growing.

During the current fiscal year the laboratory will be prepared to make routine tests of rock samples and brick as heretofore, the same requirements as to size and quantity of sample submitted for testing being in effect; that is:

(1) All samples should represent as nearly as possible an average of the material.

(2) Sample of rock must consist of stones which will pass through 3-inch but not through 1½-inch ring, excepting one piece, which should measure 4 by 6 inches on one face and be 3 inches thick, and also weigh not less than 30 pounds.

(3) Samples of gravel must weigh not less than 25 pounds and should not contain stones over 1 inch in diameter.

(4) Samples of paving brick must contain 36 whole bricks, or 24 blocks.

(5) Blank form and addressed tag envelope will be supplied by the Department.

(6) Samples must be shipped freight or express prepaid.

(7) No charge is made for tests.

GATHERING INFORMATION.

This branch of the work will show practical results in the near future, such as complete and reliable information of the expenditures for road construction and maintenance, mileage of improved and unimproved roads, amounts of bond issues, and other important information for every county in the United States. A corps of competent road correspondents is rapidly being formed representing every county in the country, and it is expected that the cooperation of this large number of special correspondents will be a powerful factor in accomplishing the purpose for which this branch of the work has been organized. As rapidly as possible the scope of the work will be broadened and a systematic and comprehensive study undertaken of economic conditions governing construction and maintenance of roads in all parts of the country.

An arrangement has been made with the Forest Service by which the latter will be aided in securing necessary information regarding forest trails by means of the public-road correspondents.

WORK OF INSTRUCTION.

In order to secure properly trained men, both for our own work and to supply the demand for highway engineers outside of the Government service, it is expected during the current year to add a number of civil-engineer students to the number already appointed. These students are required to pass a rigid competitive examination before entering the service, which practically restricts the selection to graduates of the better civil-engineering schools. The work of these students includes personal inspection and reports in detail of the methods of construction carried on by different State highway commissions in the States where work has been systematized and put upon a practical basis. They are also required to make surveys and estimates of the actual cost of building roads under various local con-

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ditions. In the actual construction work of the Office they acquire practical experience and training. Laboratory methods of testing the various qualities of road materials are thoroughly studied, so that the purpose and value of the different physical properties of the materials may be made clear to them. The work of these engineer students is of great assistance to the Office, in addition to being of much practical value to the public at large. They are appointed for one year at a salary of $600, and are reimbursed for expenses incurred while on field duty. On account of the high educational qualifications required and the rigid competitive examination, they may be retained in the service and are eligible for promotion without further examination after one year. Every effort will be made to develop this feature of the work to the fullest extent during the present fiscal year.

Training in highway engineering in schools and colleges throughout the country should receive special attention at the present time, owing to the rapid development of road building. It is of the utmost importance that a sufficient number of young men properly qualified should be available to meet the demand, which is already in excess of the supply. The Office, so far as its limited facilities will permit, will cooperate with the various educational institutions in placing this branch of education on an adequate basis and in inaugurating highway work.

PROPOSED PUBLICATIONS.

For many years the question of the binding power (cementing value) of rock dust has been under investigation, and during the past fiscal year the work has made substantial progress. The cause of this quality has been established, and it is satisfactory to note that the results of the investigation are being accepted and woven into the general literature of the subject, as it applies not only to the binding power of rock dust, but also to that of clays, which is a most important point in the ceramic industries. Bulletin No. 92, of the Bureau of Chemistry, entitled "The Effect of Water on Rock Powders," presented the results of this investigation up to the date of its publication. More recently acquired data will be embodied in a circular of the Office, by Dr. A. S. Cushman, to be issued during the early part of the current year, on the decomposition of rock powders.

A widespread feeling of dissatisfaction among the farmers of the country because of the inferior lasting qualities of modern steel fence wire is shown not only by the large number of letters received at the Department, but also by the frequent editorials and articles appearing in leading agricultural journals. Investigation of this subject is being taken up under proper authorization, and a report will be issued in due time, giving such information as can be secured upon the subject.

Mr. Archer B. Hulbert, expert in this Office, who is an authority on the history of road making, is now engaged, under the direction of the Office, in the preparation of a history of roads and road building in America. Mr. Hulbert is also making an exhaustive investigation of the literature of the subject for the purpose of preparing an accurate and complete bibliography of publications relating to roads.

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The information which is now being compiled by the Office in regard to the mileage of improved and unimproved roads, and the collection and expenditure of road funds in every county in the United States, will be published some time during the year. Later on, publications will be issued designed to aid local communities in matters of road administration. This feature of the work, however, is yet in a formative state.

Mr. Clifford Richardson, expert in cements for this Office, is preparing a bulletin on the constitution of Portland cement, which will embody the results of many years of work conducted by him.

The scarcity of wood for fence posts in many parts of the country has aroused interest in the use of concrete, reinforced or armored with iron and steel rods. A series of tests has been carried on with specially molded posts of different shapes and sizes. A bulletin describing the mixing, molding, and reinforcing of concrete for road and farm purposes is being prepared by Mr. P. L. Wormeley, testing engineer of the laboratory. The main object of this publication will be to furnish elementary information regarding the use of cement mortar and concrete to those who are unfamiliar with such work.

There is great need of accurate information relative to oiled roads, and the preparation of an exhaustive bulletin on the subject is contemplated.

In connection with legislation which is being discussed at sessions of legislatures in many States, the need of a new compilation of the road laws of all the States is very apparent. This will be undertaken and a comprehensive digest of all the laws issued, to be followed from year to year by supplementary reports.

Nearly one hundred object-lesson roads have been built under the direction of the Office, and it would seem desirable to publish a description of this work in the future.

A large number of requests have been received during the past year from county road superintendents and other county officials for standard specifications for macadam roads, and for information which would be of use in the preparation of specifications for local work. In order to meet this need on the part of rural communities the preparation of a bulletin on macadam construction and specifications will be prepared by A. N. Johnson, highway engineer of the Office. This bulletin will contain full explanations of all technical matters referred to in the specifications and methods of construction described.

Heretofore the requests of farmers' organizations for information and advice in connection with road improvement in rural communities have been answered by sending bulletins and circulars on construction and maintenance of roads. This is well enough as a matter of education and a means of creating better public opinion; but as the average farmer has neither the time nor the opportunity to put methods of road building into actual use, it is evident that the most important need in such cases is for information as to proper methods of road administration. If the improvement of country roads is placed on a proper administrative basis the question of suitable methods of construction can be worked out to meet local conditions. To supply the demand for information of this nature a bulletin on country-road administration will be prepared by the highway engineer.

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Since the publication in the Yearbook for 1903 of a paper on "Sand-clay roads" by W. L. Spoon, expert in this Office, this method of road construction has developed considerably and has assumed great importance in the sections of the country where natural hard road materials are lacking. It has accordingly been decided that this paper should be revised so as to embody the results of later investigations and experiments.

As will be seen from this report, the experimental burnt-clay road at Clarksdale, Miss., bids fair to exercise a marked influence on the question of road building in the Delta country and in the prairie States. The possibilities are such in the development of burnt clay as to warrant further experiments and the issuance of a publication on the subject. Mr. Spoon has been intrusted with the preparation of such a publication.

A new treatise on "The testing of road materials" will be issued as a bulletin of this Office in the near future. It will comprise a revision of the matter first published in Bulletin No. 79 of the Bureau of Chemistry (which was prepared by the present Director of this Office), and much additional information on the same subject.

RECOMMENDATIONS AND ESTIMATES, 1905-6.

Applications are being received daily from all parts of the United States for the detail of engineers and experts to render assistance in road improvement. The present field force and equipment are totally inadequate to meet the demand. It has been found impossible to comply with more than 10 per cent of the requests received, and there are now on file in the Office more than 100 applications which have not yet been reached. An increase in the appropriation so as to double the working force in the field is urgently needed in order to render such assistance as will meet the demand to a reasonable degree.

It is most desirable that at least ten engineer students should be trained each year in highway engineering, in order to meet the demands of the Office and to disseminate accurate information on road making. These civil-engineer students are paid at the rate of $50 per month. The sum of $4,000 is estimated for traveling and subsistence expenses of the engineer students, making in all $10,000 for this branch of the work.

The practice of having the engineers and experts of this Office travel on passes should be abolished. The amount estimated for traveling expenses, $3,300, is sufficient to do away with the pass system entirely.

The Office work has nearly trebled within the last six months, and it is essential to the success of the work that the clerical force be increased.

The work of the laboratory is constantly increasing, necessitating additional machinery and a greater expenditure of money. The broadening of the scope of the field work will also have marked effect in adding to the work of the laboratories, and accordingly $4,000 increase is estimated for apparatus and repairs. The sum of $1,000 is thought to be sufficient to cover the increase in consumable supplies.

The Office has heretofore been unable to obtain the necessary machinery for carrying on the field work except by borrowing the same

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from manufacturers. This method is obviously unsatisfactory. The question of purchasing machinery outright was carefully considered and found to be undesirable. The plan which seems to be most feasible, and at the same time most satisfactory, is to lease the necessary road machinery. It has been ascertained that the machinery required during the year can be leased at a fair and reasonable rate. The estimate of $8,250 is made for ten complete outfits.

The Office by reason of its small appropriation has been compelled to depend upon the railroads to furnish free transportation for men and machinery. This practice leads to much delay from soliciting the transportation and on account of circuitous routes which it is sometimes necessary to follow in order to secure such concessions. At the same time the propriety of such an arrangement is questionable. Accordingly, $6,600 is estimated for freight expenses, based on a maximum of ten outfits, each making 3 carloads, and constructing during the season 4 sections of road, with an average haul of 200 miles for each section of road.

It has been found impossible to secure a building offering adequate facilities for carrying on the work of the Office at a lower rental than $2,000 per annum. This necessitates an increase of $800 over the amount allowed for the current fiscal year. Under the increase of the force the items for fireman, janitor, and charwoman are made necessary by the occupancy of the rented building. This also accounts for the item of $200 for fuel.

The increase of $4,000 recommended for contingent expenses is very moderate, and is made as a result of a careful consideration of every phase of the work.

After careful estimation, in which each item of expenditure has been made the subject of exact calculation, it has been ascertained that in order to carry out adequately the plans for the next fiscal year the appropriation should be increased from $50,000, as at present, to $80,400, made up of $12,340 for statutory roll and $68,060 for miscellaneous, and recommendation to that effect is respectfully made.

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REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., September 26, 1905.

SIR: I have the honor to present herewith the report of the Office of Experiment Stations for the fiscal year ended June 30, 1905.

Respectfully,

A. C. TRUE, *Director.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

DEVELOPMENT OF WORK OF THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has continued to increase both in amount and in the extent and variety of its operations. The annual inspection of the agricultural experiment stations has been made as formerly and has shown that these institutions have made good progress in systematizing their work and in conducting investigations of scientific as well as practical value. The Office has been able to assist the stations in strengthening their work and in recruiting their staffs. Plans are now being perfected to render still more efficient aid to the stations by a more thorough study of their operations, by keeping better records of their work, and by enlarging the information given them in the Experiment Station Record through additions to the staff of this journal which will render it possible to introduce new and reorganize old departments in accordance with the most modern conception of the science of agriculture.

The demands for aid in developing and extending courses of instruction in agriculture have increased out of all proportion to the ability of the Office to render assistance. In at least thirty States elementary agriculture is now being taught in some of the public schools, but in all these localities the need of expert advice and assistance, such as might be given from this Office with only a small increase in funds, is greatly felt, and such aid is necessary in order that mistakes seriously detrimental to the progress of the movement may not be made. With a small special appropriation the Office has been able to give considerable aid to the States in developing and perfecting their farmers' institute systems and in making the institutes more like traveling schools than mere campaigns to arouse interest in farming. Several schools for institute workers

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have been held, and plans have been made for extending this feature of institute work and for inaugurating movable agricultural schools for farmers.

The work of the stations in Alaska, Hawaii, and Porto Rico has been successfully carried on and in several ways considerably extended by the special agents in charge. In Alaska some work in horticulture has been started at Sitka, and in animal husbandry and dairying at Kenai. In the other centers experiments with cereals continue to be the leading features. In Hawaii special attention has been given to grasses and forage plants, coffee and cane diseases, and tobacco. The initial experiments with tobacco have given such promising results that they are being extended. In Porto Rico good results have been obtained in the culture of coffee, and some work with rice and domestic animals has been undertaken. Continued efforts in vegetable growing have resulted in success with crops which hitherto have been failures. Experiments with citrus fruits, pineapples, bananas, yautias, cacao, and rubber are being continued and extended.

The nutrition investigations of the Office are becoming increasingly important, and their results are given wider practical application in preparing dietaries for public institutions and courses in household science for schools and colleges. Since definite knowledge of the principles of nutrition is fundamental to the health and happiness of all, there is need not only for a continuation of thorough investigations, but also for a much wider dissemination of the results already obtained, and plans to secure this are being made.

The irrigation and drainage investigations of this Office now include the investigation of all phases of rural engineering carried on by this Department except the good roads inquiry. To the studies on irrigation and drainage have recently been added investigations on the application of power to farm work. With the rapidly changing industrial conditions in this country, resulting in great scarcity of farm labor, the investigation of problems relating to power machinery, farm implements and appliances, and materials used in erecting farm structures is of the greatest importance. The demands made on the Office for the extension of its work in irrigation, drainage, and other branches of rural engineering are greater than can be met at present despite the fact that considerable financial aid has been given to this work by States and private organizations.

Relations with the Agricultural Experiment Stations.

This Office has carefully investigated the work and expenditures of the agricultural experiment stations throughout the United States during the past year, and has earnestly sought to promote their interests in numerous ways. The provisions of the act of Congress of March 2, 1887, have been strictly enforced. Personal inspection of the accounts of the stations by representatives of the Office has shown a gratifying disposition on the part of the institutions receiving the United States funds to apply them strictly in accordance with the law and, in most cases, to use them efficiently for the advancement of agriculture. In many States these funds are supplemented by State appropriations and moneys belonging to the colleges with which the stations are connected. The funds received by the stations during the past

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year from sources other than the appropriation by Congress have been considerably larger than usual, so that the income of the stations from within the States now aggregates about as much as the amount annually received from the United States. The liberality of the majority of the colleges in their attitude toward the researches and other work of the stations deserves high commendation.

As a result of the efforts of the Office there has been brought about a greater uniformity, simplicity, and accuracy in the methods of accounting used by the different stations. The stations now generally use for this purpose the forms prepared or recommended by the Office, and thus the annual inspection of accounts by the Office representatives is greatly facilitated.

In conformity with the policy consistently urged by the Office from the beginning, the use of the comparatively limited Hatch funds for the maintenance of permanent substations has been definitely abandoned, and these funds are being more than ever before confined to lines of work of more permanent scientific value. As a result of this policy an increasing number of States are beginning to supplement the Hatch fund by appropriations for conducting local experiments needed to study special problems of climate, soil, and crop, and other more practical questions. These enterprises are proving of value not only as means of studying important local problems, but as distributing centers for practical agricultural information.

In accordance with the recommendations of this Office, there is a growing tendency to make a clearer distinction between the station work and the instruction work of the college. One form which this takes is an attempt to divide the force so as to provide men for the station work who will give the majority of their time and energy to investigation, relieving them of elementary instruction, and giving them a greater amount of uninterrupted time for research. In some institutions there is a movement to provide separate officers for the station work who will do little, if any, teaching.

The strengthening of the organization of the stations has also continued during the past year along the lines urged by the Office, and gratifying progress has been made. The directorship of several of the stations has been separated from the president's office, and greater supervisory and directing power has been conferred upon the director. This policy will continue to be urged, for it is recognized that loose organization and lack of intelligent and efficient administration have been the greatest sources of weakness, and there are still a number of notable examples of the effect of these conditions.

In general, there is a marked tendency toward concentrating the work of the stations upon fewer lines and subjects, in spite of the increasing demands for their services. There is not a station but feels how incompletely it is now able to cover the field open to it and the great advantage which would result from expanding its work, but the problems are now very largely of a character that require more thorough investigations, and the stations are wisely following this policy of concentration which the Office has consistently advocated.

The stations are becoming increasingly important as agencies for the dissemination of information and advice for improved farm practice. Almost without exception they are in very close touch with the farmers of their respective States and enjoy their confidence to a degree that imposes an increasing burden upon their resources. The

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plan of demonstrating the results of station work upon private farms in cooperation with the owners has given very important returns in the way of introducing new methods and more efficient practice. While it is regarded merely as a demonstration, and not relied upon to take the place of experiments, no other plan has been devised which has been so successful in reaching the farmers and leading them to apply the results of experimental investigations.

The Office has been of material aid to the stations in disseminating the practical results of their work, not only through publication of popular bulletins, but also through the work of its Farmers' Institute Specialist in promoting the organization and development of farmers' institutes throughout the country. There is being built up a well-trained body of lecturers who can relieve station investigators to a large extent of the exactions of institute work and still give farmers the results of their work in a form to be practically useful.

From its extended knowledge of men and their ability in special lines, the Office has been able to assist the agricultural colleges and the experiment stations in recruiting and building up their forces to a greater degree than ever before. This is becoming an important function of the Office. The calls for aid in this direction are increasingly numerous.

The advisory relations of the Office with the stations in the development of their organization and work, and in other matters, have been closer than ever before, and many gratifying evidences of the cordial relations of the stations with this Office have been manifested during the past year.

The great need of increased funds for the work of the stations is becoming more apparent every year the country over. Never has there been a time when the practice of agriculture has been so largely and profitably modified by the results of experimental investigations as during the past year. The farmers are more and more looking to the stations for advice and assistance. To keep pace with the demands made upon them it is imperatively necessary that they should increase the scope, extent, and thoroughness of their researches. This can undoubtedly be done to a limited extent by improving their organization and methods of work, but in the main it will only be possible to make them more effective agencies for the improvement of agriculture by increasing their resources and those of the colleges of agriculture with which they are connected. The colleges must have the means to properly care for and instruct the increasing number of students coming to them without in any way limiting the work and equipment of the stations, and the stations must have sufficient means to enable them to organize their staffs for the most part without reference to the instructional needs of the colleges, and to conduct researches commensurate with the importance of the agricultural interests which it is their business to promote. It is therefore much to be hoped that Congress will at an early day take favorable action in the line of legislation already definitely formulated for the benefit of the experiment stations organized under the act of 1887.

Cooperative work between the stations and this Department continues to increase, and there is a general desire to further extend such work, especially on the part of those stations whose funds are inadequate to meet the agricultural needs of their respective States. Questions of general policy regarding the management of cooperative en-

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terprises have been carefully considered by the stations during the past year, and considerable progress has been made in the adjustment of administrative difficulties. The close relations which the stations hold with farmers in their respective States, and their intimate acquaintance with the local needs and requirements of agriculture, make it very desirable that in all cooperative work the arrangement shall be such as to aid the station to strengthen its position with its own constituency, and to recognize to the full extent the knowledge and experience already gained by the station. This Office has continued to keep a record of the cooperative enterprises arranged for between the Department and the stations, as reported by the different Bureaus, and has to a considerable extent aided in the making of such arrangements.

The ninth annual examination of the work and expenditures of the agricultural experiment stations which receive the national funds appropriated under the act of Congress of March 2, 1887 (Hatch Act), with special reference to the fiscal year ended June 30, 1904, was made during the past year in accordance with the authority conferred upon the Secretary of Agriculture by Congress, and a report of this investigation was prepared for transmission to Congress, as required by law. This report was published as House Document No. 421, Fifty-eighth Congress, third session, in accordance with a joint resolution passed by the Fifty-eighth Congress, providing for the publication annually of 8,000 copies of this report, 5,000 of which are to be for the use of this Department.

As heretofore, the report was based upon three sources of information, viz, the annual financial statements of the stations rendered on the schedules prescribed by the Secretary of Agriculture in accordance with the act of Congress, the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made during the year by the Director, Assistant Director, and two other expert officers of the Office of Experiment Stations.

With a view of perfecting the organization of the Office in its relations with the stations and securing prompt settlement of matters brought out in connection with the visitation of the stations, the Assistant Director of this Office has recently been charged with the supervision of the business of the Office connected with the finances of the stations.

This Office has continued to follow and record the progress of agricultural experiment stations in foreign countries and to publish accounts of their organization, resources, and work in the Experiment Station Record and elsewhere. A revision of Bulletin 112, which contains an account of 798 such institutions arranged in alphabetical order by countries and cities, was published and distributed during the year.

Relations with Institutions for Agricultural Education.

The past year has been one of great progress in agricultural education. This has been manifested in a material way by more liberal appropriations for the equipment and current expenses of the agricultural colleges and by the increased enrollment of students in the

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agricultural courses, and in a less tangible but no less hopeful and wholesome way by the attitude of the general public toward agricultural education. At no time in the history of the Republic has there been such free and favorable discussion of ways and means for developing and extending the various phases of agricultural education as during the past year. The discussion of agricultural college extension work and of secondary and elementary courses in agriculture has been especially noticeable. At the convention of the Association of American Agricultural Colleges and Experiment Stations there was a lengthy discussion of extension work as a branch of agricultural college work. It was agreed that to carry out the function of the agricultural college there is need of a great enlargement of extension work among farmers, which should be dignified by a standing in the college coordinate with research and the teaching of students. It should rank as a distinct department with a faculty whose chief business should be to teach the people who can not come to the college.

Elementary agricultural instruction was one of the prominent subjects of discussion at the recent annual convention of the National Educational Association, and it enjoyed the distinction of special mention in the annual address of the president of the association, delivered to thousands of teachers at the opening session. The president commended the teaching of agriculture in public schools in strong terms, pointing out its advantages to the people in rural communities, and to the nation as well, in the greater efficiency of its agricultural population. He declared the teaching of agriculture in a practical manner to be just as necessary for the rural school as manual training is for the city school. The subject was also referred to in a report upon the educational progress of the year by Howard J. Rogers, first assistant commissioner of education of the State of New York, who had charge of the educational exhibits at the Louisiana Purchase Exposition, and by several others who gave addresses at the convention. More important than all this, however, was the report of a special committee on industrial education in schools for rural communities. The report of such a committee was in itself a significant fact, and this was further emphasized by the prominent place given it in the programme and discussions of the association. The committee consisted of an ex-superintendent of public instruction in Wisconsin, now superintendent of a city school system; the State superintendents of public instruction in Illinois and Missouri; the director of the New York College of Agriculture and Cornell Experiment Station, and the Assistant Secretary of this Department. The report was an elaborate one, comprising nearly a hundred pages; and in addition to giving the arguments for industrial education in rural schools, discussing the form which this should take in different grades of schools, the advantages of consolidated schools, and the preparation of teachers of industrial subjects, it outlined syllabi for courses in nature study, agriculture, and domestic economy for various conditions.

In general, the committee maintained that the rural schools, which train nearly one-half of the school population of this country, should recognize the fact that the major portion of their pupils will continue to live upon the farm, and should provide specific, definite, technical training fitting them for the activities of farm life. It adduced

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strong arguments in support of this position, and emphasized the educational value as well as the practical utility of courses of study framed with this end in view.

The reports of many educational meetings of less general importance that those mentioned have contained numerous papers and discussions on the subject of agricultural education, and so, too, have the columns of hundreds of newspapers and magazines. Three elementary text-books of agriculture and many bulletins, pamphlets, and circulars containing courses of study and exercises in agriculture, nature study, and school gardens suitable for secondary and elementary schools have been prepared during the year by teachers in our agricultural colleges and schools. But the demand for agricultural literature suitable for the common schools has not been satisfied. Book publishers are seeking for men who can prepare the right kind of elementary agricultural text-books, and many county newspapers have been printing syndicated lessons in elementary agriculture.

However, the suitable literature already available has made it possible to conduct secondary and elementary school courses in agriculture with such a degree of success as to give a wonderful impetus to the establishment of special schools of agriculture and the inauguration of agricultural courses in the public elementary and secondary schools. During the past year at least a dozen States have entered the list of those giving encouragement to work of this nature, so that now more than thirty States either encourage or permit the teaching of agriculture in public schools.

With the rapid growth in sentiment and action toward placing the benefits of an agricultural education within easy reach of all people in rural communities have come demands upon the Office of Experiment Stations which with its present income and staff it is unable to meet. The Office is now generally and favorably recognized as the agency of this Department for the promotion of agricultural education. During the past year it has published a circular on the Teaching of Agriculture in the Rural Common Schools, and a leaflet giving a list of the educational publications of the Office, both of which have been widely distributed; it has revised and reprinted its abridged list of books and bulletins on nature study, school gardening, and elementary agriculture suitable for common schools; prepared an article on Boys' Agricultural Clubs for the Yearbook of the Department, and one on The American System of Agricultural Education for the International Congress of Agricultural Education at Liège, Belgium; published in its Annual Report a review of progress in agricultural education for 1904 and an article on the county schools of agriculture in Wisconsin, and gathered data for a publication describing and illustrating apparatus and illustrative material available for use in teaching elementary agriculture. A card directory of about 1,200 teachers and investigators in agricultural subjects has been prepared for use in the Office, and about 1,000 cards of agricultural educational institutions in foreign countries have been written. Upward of 200 lantern slides illustrating different phases of agricultural education have been prepared and used frequently in illustrating addresses before meetings of teachers, school officers, and children. Over twenty lectures and other addresses on elementary instruction in agriculture have been given by

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one member of the Office staff during the year, principally before bodies of teachers, and the Director has addressed several representative assemblies of teachers and farmers on the same subject.

A representative of the Office attended the International Congress of Agricultural Education at Liège, Belgium, during the year, and two members of the Office staff (the Director and Mr. Beal) were made members of the international committee appointed by that congress to give continuity and permanency to the work of the congress.

During the ensuing year the educational work of the Office will be continued, but owing to the lack of funds and other facilities there will be little opportunity to broaden the work except through the Experiment Station Record, in which arrangements have already been made for a department of agricultural education. There are many ways, however, in which the Department might, with a relatively small increase in its funds, so broaden and extend its educational work as to render much more valuable aid to the cause of agricultural education than it is now doing, and at the same time aid in bringing the whole Department into more intimate and helpful relations with the people for whom its work is being done.

There never was a time when teachers and other school authorities were giving so much attention and study to the preparation of courses in elementary agriculture and the introduction of this work into the public schools. There are abundant opportunities for this Department to aid this forward movement if funds were provided and the way were made clear for more actively undertaking educational propaganda.

In the educational work of this Office during the last three years it has been demonstrated that there is a general lack of knowledge of the publications of this Department—their nature and how to secure and use them—among teachers and others interested in improving the conditions of our rural schools. Few people, comparatively, know that this Department has issued and is issuing numerous publications which would be of incalculable value if properly used in connection with the country schools. There is need of systematic and continued effort to get such publications into the hands of the superintendents and teachers of country schools and into the libraries of these schools, so that the children of the farmers may become familiar with them and be taught how to secure and use them. Communication with these superintendents and teachers can be established through the State officials in charge of public schools, who have always been found willing to cooperate with this Department in any movement for the promotion of better conditions in these schools.

Several of the leading agricultural colleges are lending their aid to the movement for the improvement of the rural schools by maintaining extension departments. They are coming to recognize the fact that they are not doing their whole duty to their constituency by simply instructing those who enroll for their college courses, but that their help should be extended in some measure to all the people of the State and that there should be some well-recognized agency to take charge of this extension work. This Department might be of great service to the extension departments of the colleges if it had a regular agency through which to bring to the college officers in charge

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of this work the information possessed by its specialists, its publications, and its agricultural library.

The Department might also promote the introduction of instruction in agriculture in the public schools through (1) correspondence with teachers and other school authorities; (2) public addresses at meetings of educational organizations; (3) study of foreign systems of elementary agricultural schools and preparation of suggestive courses of study based on the most successful experiments along this line in this country and abroad; (4) the devising and securing of apparatus and illustrative material to aid in presenting courses in elementary agriculture, and (5) the publishing of accounts of buildings, grounds, equipment, and courses of study of agricultural schools already established, and lists of agricultural books suitable for school libraries.

In order to permit this Office to extend its educational work in some of these directions I have recommended an increase of $5,000 in the appropriations for the Office for the next fiscal year.

The Farmers' Institutes.

The work of this Office in relation to the farmers' institutes has been in charge of Prof. John Hamilton, as hitherto.

The condition of the farmers' institutes throughout the country is approximately shown by the data furnished by the several State directors who have sent in statistical reports for the year ended June 30, 1905. The reports received from 42 States show that 3,096 institutes were held during the year, composed of 10,153 sessions. Reports from 41 States and Territories show a total attendance of 977,082, and that the total cost of the institutes was $204,975. Nine hundred and ninety-two lecturers were employed by the State directors in giving instruction, 338 of whom were from the faculties of the agricultural colleges and the staffs of the experiment stations. The whole number of days of institutes reported is 4,598.

If the four States that have not yet reported have held their own in all respects, the total attendance for the year will show an increase of 185,324, and an increase in the number of sessions held amounting to 188. The appropriations for institute purposes will exceed those of the previous year by about $20,000.

The work of the Farmers' Institute Specialist during the year has been that of continuing aid to the State directors by distributing literature, attending meetings of representative farmers, delivering addresses before farmers' organizations, aiding in the preparation of bulletins and circulars of information, perfecting the organization of the work of the Office, and conducting correspondence.

During the year the States of Delaware, Iowa, Minnesota, Missouri, North Carolina, North Dakota, New York, Pennsylvania, Texas, West Virginia, and the Province of Ontario were visited and seventeen addresses were delivered.

A statistical report of the farmers' institute work of the country was prepared for the Yearbook of the Department, and an extended institute report was prepared for the Annual Report of the Office of Experiment Stations for 1904. A bulletin on Agricultural Instruction for Adults in the British Empire was prepared and is now ready for

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distribution. Assistance was also given in the editing of the Proceedings of the Ninth Annual Meeting of the American Association of Farmers' Institute Workers, which has been issued as a bulletin of this Office.

Six illustrated lectures prepared by expert scientists were edited under the general supervision of the Farmers' Institute Specialist, embracing the following subjects: Care of Milk, illustrated by 44 lantern slides; Potato Diseases and Their Treatment, illustrated by 47 lantern slides; Acid Soils, illustrated by 53 lantern slides; Profitable Cattle Feeding, illustrated by 45 lantern slides; Silage and Silo Construction for the South, illustrated by 50 lantern slides, and Essentials of Field Experimentation, not yet printed.

Bulletin No. 135, entitled "Legislation Relating to Farmers' Institutes in the United States and the Province of Ontario," has been revised.

The list of farmers' institute lecturers, known as Circular No. 51 of the Office of Experiment Stations, was revised and furnished to the State directors of institutes and also to the directors of the experiment stations, accompanied with the request to the station directors that their official publications be sent regularly to those whose names have been thus supplied. The names of 1,586 local institute managers have been secured, and arrangements have been made for supplying these persons with farmers' institute literature.

Correspondence with farmers' institute workers and others has been conducted during the year, information given, and a large number of the Department publications have been distributed.

Material has been collected and compiled for a history of the farmers' institute movement in the United States, and also for a bulletin on agricultural education for adult farmers in foreign countries.

Arrangements have been completed with a number of experts for the preparation of courses of study, together with practicums suited to each course, for use in movable schools of agriculture. The courses are on the following subjects: Poultry rearing, cheese making, butter making, and fruit growing. Abstracts of these courses have been submitted and proper authorizations have been issued for their completion.

Several thousand copies of an address by the institute specialist on Normal Schools of Agriculture for Farmers' Institute Workers were, through the courtesy of the director of farmers' institutes of the State of Pennsylvania, printed in pamphlet form and placed at the disposal of this Office. Many of these were sent out, accompanied by a letter calling attention to the publication. A large number of replies have been received, all cordially approving the purpose which the pamphlet advocates, and, with a few exceptions, indorsing the method proposed.

The exhibit room at the St. Louis Exposition assigned to the farmers' institute workers of the country was supplied during the continuance of the exposition with suitable literature and illustrative material.

Much study has been devoted to questions relating to the most efficient organization of State, county, and township institutes with a view to securing greater permanence and thoroughness in the work

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of the institutes and reaching the masses of farmers as yet unaffected by this movement.

Two new features have been developed in the farmers' institute work during the year in the direction of the improvement of the system. One was the holding of institutes devoted to a single topic, such as butter making, cheese making, poultry rearing, etc. These meetings were each continued for at least three days and were conducted by a corps of specialists who confined their instruction to the particular topic that the institute had been called to consider.

The other new feature was the holding of a school of methods for farmers' institute workers. This school took up the work of the State director, the lecturer, the local manager, the presiding officer, and the various committees that have charge of the working up of the institutes. The first of these new departures looks toward the making of the instruction in the institute more reliable and complete, and the other to the improvement of the methods in use in institute work.

Normal schools for farmers' institute workers were held in New York, Pennsylvania, West Virginia, and Illinois, with varying degrees of success. The purpose in all of these has been to endeavor to better fit the worker, particularly the lecturer, for institute service. The need for more and better teachers is the most pressing that now confronts the institute director, and it is realized that unless qualified instructors are supplied in greater numbers the work can not continue to develop. The matter therefore is of vital importance, and the movement in the States referred to is an effort to meet the difficulty by assembling their institute teachers once each year for a week or ten days for the purpose of receiving instruction at the hands of scientific experts along the lines of their several specialties.

The National Department of Agriculture could greatly assist the States in this respect if it had the means for sending lecturers to aid the State directors in their normal schools of instruction, and also for giving the institute workers systematic information at their homes through correspondence. Both of these methods of imparting instruction have been sufficiently tested to demonstrate their value. All that is needed to insure success is a body of experts who can be depended upon to give their time regularly to such work.

The Department might also assist the States in developing the other new feature of the institutes referred to—the specializing of instruction. This work might be expanded beyond the holding of a two or three day institute for the discussing of a single topic, to the forming of movable schools, presenting courses in special lines of agriculture that would each continue for two or three weeks in a locality and then be transferred to another.

The institutes of the present time have devoted themselves chiefly to creating an interest in agriculture. They have shown to farming people that there is a large amount of scientific information in existence that is valuable for their use, and they have demonstrated also that it is possible to present this scientific information in an understandable way to men and women who have never had scientific training. The institutes have done this largely by means of lectures covering a great variety of agricultural topics, the lecture being in no case a complete discussion of any branch or topic, but merely the presentation of a small part of the great subject to which it refers.

The new method proposes to concentrate instruction on a single

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agricultural operation and teach that as thoroughly as possible by means of courses of study and practicums prepared especially for rural classes whose members would pledge themselves to enter upon such a course. By attendance upon a course of this character farmers who are interested in self-improvement would have the advantage of instruction by an expert on important agricultural subjects, continued for a period sufficient to enable them to become quite well informed on at least a single branch, and be equipped for applying what they have learned to the actual operation of their farms.

Into this new field the Department of Agriculture might enter by selecting and sending out experts and supplying them with appropriate apparatus for giving instruction in one or more agricultural specialties, and especially in subjects connected with the work of the Department, doing this with the consent of and in cooperation with the State officials in charge of the institute work. During the introductory stages of the movement this Department might act largely as a demonstrator, showing the methods that ought to be pursued in conducting this work, and the practicability and usefulness of the new system. This feature of education for adult farmers, although new in this country, has been successfully carried out both in Great Britain and on the continent of Europe. It is only in some such way as this that the work of the Department and the experiment stations can be effectively brought home to the masses of our farmers who are not prepared to understand thoroughly and apply the information contained in publications without oral explanations to supplement the printed page.

In former reports attention was called to the importance of having suitable charts prepared for the use of the farmers' institute lecturers. This is a matter of sufficient importance to justify its presentation again. The proposition is for the Department to secure the services of experts to prepare agricultural charts and have them printed and properly mounted for use. Work of this character is assumed by governments abroad, and advantage in some of these countries has been taken by colleges and lower schools to secure sets for use in classroom work.

To enable this Office to extend its work relating to the farmers' institutes by the more thorough organization of the office of the Farmers' Institute Specialist, the employment of two lecturers competent to give itinerant courses of instruction on subjects connected with the various lines of work of the Office of Experiment Stations, and the preparation and printing of charts and illustrated lectures for the use of farmers' institute lecturers, I have recommended an increase in the appropriation for this Office to be devoted to these purposes.

Cooperation on the part of the various Bureaus, Divisions, and Offices of this Department in the farmers' institute work has been solicited, but it has been apparent that only in a few instances could members of the regular force be spared from their ordinary duties to make addresses at the institutes. The Bureau of Plant Industry furnished an expert for about six weeks to explain certain features of its seed testing and investigation work at the farmers' institutes of Pennsylvania, with excellent results. The Chief of that Bureau has arranged for two members of his force to perform similar service during the coming institute season. If cooperation of this character could be

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secured generally with all of the representative interests of this Department, the service would not only be appreciated by the State directors of institutes, but would do much to popularize the Department's work by placing directly in the possession of the men who need help valuable information which the Department has at hand, much of which under existing conditions is virtually inert. This service might be performed under some such plan as the following: (1) Each Bureau or Division to employ one or more specialists whose chief business should be to lecture at farmers' institutes and agricultural schools on subjects connected with the work of the Bureau or Division to which they severally belonged; (2) the expenses of each lecturer to be borne by the Bureau or Division which he represents, and (3) arrangements for scheduling the speakers to be committed to the Farmers' Institute Specialist of the Office of Experiment Stations, who would make arrangements for this work through the State directors of institutes.

Publications of the Office.

The publications of the Office may be conveniently grouped in four main classes: (1) Experiment Station Record, which gives a technical review of the current literature of agricultural investigation throughout the world, and Experiment Station Work, which is published periodically in the Farmers' Bulletin series of the Department, and gives a popular summary of some of the more salient practical results of the work of the experiment stations. To these should be added the bimonthly list of experiment station publications which is now regularly published by the Office. (2) Publications relating to the food and nutrition of man, consisting of technical and popular bulletins, circulars, etc., reporting or based upon the results of nutrition investigations conducted under the auspices of the Office. (3) Publications relating to irrigation and drainage, which include reports, technical and popular bulletins, circulars, etc., giving the results of the irrigation and drainage investigations of the Office. (4) Miscellaneous publications, including those relating to agricultural education in general, including farmers' institutes, proceedings of the Association of Agricultural Colleges and Experiment Stations, and of the Association of Farmers' Institute Workers, annual reports of the Director and of the Office of Experiment Stations, and similar publications.

During the year the Office published 55 documents, not including revised reprints, separates, etc., aggregating 4,576 pages. These documents include 12 numbers of Experiment Station Record, 11 technical bulletins, 2 bulletins of the Porto Rico Experiment Station (English and Spanish editions), 1 bulletin of the Hawaii Station, 1 report, 5 Farmers' Bulletins (including 4 numbers of the subseries Experiment Station Work), 6 circulars, and 3 articles for the Yearbook of the Department. One other number of the Experiment Station Record, 6 technical bulletins, 1 report, 1 Porto Rico Station bulletin, 1 Farmers' Bulletin, 1 farmers' institute lecture, 1 circular, and several miscellaneous documents containing about 2,400 pages, were prepared and submitted for publication before the close of the fiscal year. The policy of reprinting separates of individual articles contained in larger reports has been continued with satisfactory results.

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Thirty-five such separates, aggregating 807 pages, have been reprinted in editions of varying size to meet the actual demands for the articles. Several documents, particularly those relating to the work and expenditures of the State agricultural experiment stations, as well as of those of Alaska, Hawaii, and Porto Rico, which were formerly printed separately, were combined in the Annual Report of the Office of Experiment Stations, for the printing of which Congress has made special provision.

Several of the earlier technical and farmers' bulletins of the Office were exhausted during the year and were reprinted, in many cases with complete revision or more or less important additions and corrections. Six of the earlier numbers of Experiment Station Record were reprinted in limited editions to complete sets.

EXPERIMENT STATION RECORD.

The sixteenth volume of this review of agricultural science was issued during the year in twelve (monthly) numbers, one of which was the index number. The volume comprises 1,225 pages and contains abstracts of 338 bulletins, 37 circulars, and 51 reports of the experiment stations in the United States, 243 publications of the Department of Agriculture, and a very large number of foreign publications. The total number of abstracts is 4,503, classified as follows: Chemistry, 334; botany, 132; fermentation and bacteriology, 36; zoology, 90; meteorology and climatology, 121; air, water, and soils, 168; fertilizers, 176; field crops, 332; horticulture, 333; forestry, 197; seeds and weeds, 72; diseases of plants, 269; entomology, 394; foods and nutrition, 348; animal production, 300; dairy farming and dairying, 371; veterinary science and practice, 542; technology, 6; agricultural engineering, 142; miscellaneous, 140.

The volume contains condensed accounts, prepared especially for it, of the new live-stock building at the Minnesota College of Agriculture; the annual meeting of the American Veterinary Medical Association, by E. V. Wilcox; the convention of the Association of Official Agricultural Chemists, 1904; the convention of the Association of American Agricultural Colleges and Experiment Stations, by E. W. Allen, and the new agricultural building at the North Carolina College of Agriculture and Mechanic Arts. The following topics are discussed in the editorials: Hon. Joseph H. Brigham, Assistant Secretary of Agriculture; a tribute to agricultural research; the experiment stations of the world; a refinement of methods of investigation; Maj. Henry Elijah Alvord, deceased; attendance at the agricultural colleges; "School of Agriculture" at the St. Louis Exposition; service of station men in the dual capacity of instructor and investigator; is teaching advantageous to station investigation; the experiment stations and university extension; winter meeting of the American Association for the Advancement of Science; some advantages of scientific gatherings to the investigator; retirement of Dr. W. C. Stubbs; relation of teaching force to students in agriculture and horticulture; has the teaching force kept abreast of the demand for agricultural instruction; what should be the basis in developing the teaching of agriculture; the experiment stations as publishing agencies; the agricultural appropriation act,

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1905–6; the statistics of irrigation; development of irrigation investigations in the Department of Agriculture; the semicentennial of the agricultural college; rise of agricultural education in the United States; the outlook for agricultural instruction; avenues open to graduates in agriculture; experimental work of the late James Mason; relative position of the central and branch stations; list of abbreviations used in the Record; President H. H. Goodell, deceased; credit for high-school work in agriculture; an experiment station conference; agricultural instruction at the National Educational Association, and semicentennial of Pennsylvania State College.

During the year a list of abbreviations used in referring to periodicals in Experiment Station Record was completed. This is a publication of 74 pages, and contains abbreviations for about 1,600 periodicals, which are referred to constantly in the Record. The full title of the publication and the place from which it is issued are given in each case. Owing to the fact that at least ten languages are represented in these periodicals, and that they are of quite diverse character, the preparation of this list and the maintenance of consistency has been a painstaking piece of work.

The requests for earlier numbers of the Record in order to complete sets have been very large during the year, and a special effort has been made to meet requests coming from libraries and public institutions. The number of available copies became so much reduced that reprints of about 40 separate numbers, mostly from earlier volumes, were secured in small editions.

The edition of the Record was increased during the year to 6,500 to meet the growing demands for it.

The Superintendent of Documents reported at the close of the fiscal year that there were 318 names on his list of regular subscribers to the Record. As he also receives a considerable number of irregular applications, he requests that he be furnished as many copies as can be spared.

The Department Library is receiving regularly about 65 periodicals in exchange for Experiment Station Record. Most of these are of scientific character, and a large proportion of them are foreign periodicals which the Department would otherwise be obliged to subscribe for.

EXPERIMENT STATION WORK.

This series of bulletins, which gives popular summaries of some of the more important practical results of experiment station work, attempts to do for the practical farmer what the Experiment Station Record does for the investigator and technical reader. Mr. W. H. Beal has the general editorial management of this series, the articles for which are prepared by the members of the editorial staff of the Experiment Station Record. The bulletins are now issued at bimonthly intervals, first in large editions in the regular series of Farmers' Bulletins of the Department, and afterwards in smaller editions with consecutive pages, so that they may be bound, with index, table of contents, etc., in convenient form for reference. The abundant supply of valuable material available for the preparation of these bulletins makes it desirable to issue them promptly at stated intervals, the topics for discussion being selected with reference to the needs of the readers at the time of issue of the bulletins. Four num-

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bers were issued during the past year, and a fifth was prepared for the printer. The nature of the contents of these bulletins is shown by the following list of subjects treated in the four numbers issued during the year:

Experiment Station Work, XXVI (Farmers' Bulletin 202, pp. 32, figs. 9).—Reclamation of flood-damaged lands, mulching vegetables and fruits, the cultivation of orchards, thinning of apples, pop corn, fruit for farm animals, home-grown *v.* purchased protein for dairy cows, cost of raising calves and pigs from birth to maturity, manufacture of sage cheese, manufacture of cottage cheese, a cheap fruit evaporator.

Experiment Station Work, XXVII (Farmers' Bulletin 210, pp. 32, figs. 7).—Preservation and value of hen manure, nitrate of soda for field crops, varieties, culture, and quality of wheat, breeding corn of special composition, effect of irrigation on the quality of crops, the effect of shading strawberries and vegetables, injuries to shade trees, soft corn and its value for beef production, hay substitutes, oak leaves as forage, the covered milk pail, canning cheese, millet seeds for hogs, fertilizers for potatoes.

Experiment Station Work, XXVIII (Farmers' Bulletin 222, pp. 32, fig. 1).—Home mixing of fertilizers, growing sweet-corn seed in the South, Kherson oats, cowpea hay, weight per quart of feeding stuffs, suggestions regarding grain rations, recent horse-feeding tests, market classes and grades of swine, silage in place of grain for dairy cows.

Experiment Station Work, XXIX (Farmers' Bulletin 225, pp. 32, figs. 6).—Injury to agriculture by smoke and gases, incompatibles in fertilizer mixtures, value of flint varieties of corn, buying and judging seed corn, tobacco seed, cowpea seed, treating seed oats for smut, potato culture, further points in tomato growing, influence of feed on milk, protecting cows from flies, recent experiments with turkeys, grit and mineral matter for chickens, a successful brooder house, Camembert cheese making in the United States, prevention of swelling in canned peas.

BIMONTHLY LIST OF STATION PUBLICATIONS.

These lists continue to be issued regularly. The demand for them has made it necessary to increase the edition printed. Six of the lists were issued during the year (Documents Nos. 722, May and June, 1904, pp. 10; 732, July and August, 1904, pp. 8; 745, September and October, 1904, pp. 6; 751, November and December, 1904, pp. 8; 759, January and February, 1905, pp. 10; 774, March and April, 1905, pp. 10).

NUTRITION PUBLICATIONS.

The publications relating to the food and nutrition of man issued by the Office during the year are noted on page 474. These consisted of 3 technical bulletins, 1 Farmers' Bulletin, and 2 miscellaneous articles, besides revisions and reprints of several bulletins, circulars, etc.

IRRIGATION AND DRAINAGE PUBLICATIONS.

The publications of the Office on irrigation and drainage are noted on page 493. They include 5 technical bulletins and reports, 2 circulars, and 2 miscellaneous articles, besides a number of reprints.

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MISCELLANEOUS PUBLICATIONS.

The miscellaneous publications of the Office consist chiefly of (1) technical bulletins, reports including those on agricultural education, and farmers' institute lectures and other documents, and (2) Farmers' Bulletins, including the series known as Experiment Station Work (see p. 453). The editorial work involved in the preparation of these publications for submission to the Division of Publications constitutes the special business of the Editorial Division of this Office, of which Mr. W. H. Beal is chief, although the general supervision of all other editorial work of the Office, except that directly related to the Experiment Station Record, is also intrusted to this division.

TECHNICAL BULLETINS.

Agricultural Experiment Stations in Foreign Countries, by A. C. True and D. J. Crosby (Bulletin No. 112, revised, pp. 276), gives the latest obtainable information regarding organization, history, equipment, income, and lines of work of 798 experiment stations and similar institutions arranged in alphabetical order by countries and cities.

Organization Lists of the Agricultural Colleges and Experiment Stations in the United States (Bulletin No. 151, pp. 92 + xviii) contains the staff of the Office of Experiment Stations; lists of officers of the Association of American Agricultural Colleges and Experiment Stations, Association of Official Agricultural Chemists of the United States, Association of Economic Entomologists, and American Association of Farmers' Institute Workers, and a list of agricultural colleges and experiment stations in the United States, with governing boards, courses of study, boards of instruction, and station staffs. The bulletin also contains a complete index of names.

Proceedings of the Ninth Annual Meeting of the American Association of Farmers' Institute Workers, held at St. Louis, Mo., October 18–20, 1904, edited by W. H. Beal and John Hamilton for the Office of Experiment Stations, and G. C. Creelman for the association. (Bulletin No. 154, pp. 91.)

Propagation and Marketing of Oranges in Porto Rico, by H. C. Henricksen (Porto Rico Station Bulletin No. 4, pp. 24, pls. 6, figs. 4), gives a description of methods intended for the instruction of "small nurserymen and planters throughout the island, or those men who are without experience in propagating and growing oranges and other citrus fruits." Also published in the Spanish language.

Tobacco Investigations in Porto Rico during 1903–4, by J. van Leenhoff, jr. (Porto Rico Station Bulletin No. 5, pp. 44, pls. 5, fig. 1), describes methods of tobacco culture now practiced in Porto Rico and reports the results of experiments by the Porto Rico Station in growing, curing, and fermenting tobacco, with suggestions as to improvement of methods of culture and curing.

Methods of Milking, by F. G. Krauss (Hawaii Station Bulletin No. 8, pp. 15, figs. 5), gives the results and conclusions from a 30 days' trial of the Hegelund or Danish method of milking as conducted at the Kamehameha Boys School dairy, and discusses the importance of introduction of more careful methods of milking in Hawaii.

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REPORTS.

Report of the Director of the Office of Experiment Stations for 1904, by A. C. True (Annual Reports, U. S. Department of Agriculture, pp. 445–523), contains a summary of the work of the Office during the year.

FARMERS' INSTITUTE LECTURES AND OTHER DOCUMENTS.

Syllabus of Illustrated Lecture on the Care of Milk, by R. A. Pearson (Farmers' Institute Lecture No. 1, pp. 12, lantern slides 44).

One of a series of syllabi which is being prepared by the Office for the use of farmers' institute lecturers.

Syllabus of Illustrated Lecture on Potato Diseases and Their Treatment, by F. C. Stewart and H. J. Eustace (Farmers' Institute Lecture No. 2, pp. 30, lantern slides 47).

One of a series of syllabi which is being prepared by the Office for the use of farmers' institute lecturers.

Syllabus of Illustrated Lecture on Acid Soils, by H. J. Wheeler (Farmers' Institute Lecture No. 3, pp. 28, lantern slides 53).

One of a series of syllabi which is being prepared by the Office for the use of farmers' institute lecturers.

Syllabus of Illustrated Lecture on Profitable Cattle Feeding, by F. B. Mumford (Farmers' Institute Lecture No. 4, pp. 21, lantern slides 45).

One of a series of syllabi which is being prepared by the Office for the use of farmers' institute lecturers.

Organization and Work of Agricultural Experiment Stations in the United States, by D. J. Crosby (Document No. 708, pp. 24, pls. 5).

A descriptive pamphlet prepared primarily for distribution at the exposition at St. Louis.

Farmers' Institutes in the United States, by J. Hamilton (Document No. 711, pp. 20).

A descriptive pamphlet prepared primarily for distribution at the exposition at St. Louis.

YEARBOOK ARTICLE.

Boys' Agricultural Clubs, by D. J. Crosby. (Yearbook of the Department of Agriculture, 1904, pp. 489–496, pls. 3.)

CIRCULARS.

Rules and Apparatus for Seed Testing [adopted by the standing committee on methods of seed testing of the Association of American Agricultural Colleges and Experiment Stations]. (Circular No. 34, revised, pp. 24, figs. 11.)

List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers of the United States, by John Hamilton. (Circular No. 51, revised, pp. 32.)

A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools, by D. J. Crosby. (Circular No. 52, revised, pp. 4.)

The Teaching of Agriculture in the Rural Common Schools. (Circular No. 60, pp. 20.)

This is the ninth report of the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations, presented at the convention of the association at Des Moines, Iowa, in November, 1904. It discusses the development of industrial training in the common schools, the movement to intro-

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duce agriculture into the rural schools and the obstacles encountered, the object of such instruction, and gives a programme for such instruction, including nature study and elementary agriculture, with a syllabus of an elementary course in agriculture.

Statistics of Land-Grant Colleges and Agricultural Experiment Stations, 1904. (Circular No. 61, pp. 9.)

The miscellaneous documents prepared and submitted for publication but not printed before the end of the fiscal year include:

Proceedings of the Eighteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Des Moines, Iowa, November 1–3, 1904 (Bulletin No. 153, pp. 138).

Agricultural Instruction for Adults in the British Empire, by J. Hamilton (Bulletin No. 155, pp. 96).

Annual Report of the Office of Experiment Stations for the year ended June 30, 1904 (Report 1904, pp. 724, pls. 42, figs. 11).

Tobacco Investigations in Porto Rico during 1903–4 (Spanish edition), by J. van Leenhoff, jr. (Porto Rico Sta. Bul. No. 5, pp. 47).

The Yautias, or Taniers, of Porto Rico (English and Spanish editions), by O. W. Barrett (Porto Rico Sta. Bul. No. 6, pp. 27, pls. 4).

Insect Enemies of Tobacco in Hawaii, by D. L. Van Dine (Hawaii Sta. Bul. No. 10, pp. 16, figs. 6).

Experiment Station Work, XXX (Farmers' Bul. No. 227, pp. 32, figs. 2).

List of Abbreviations Employed in Experiment Station Record Referring to Titles of Periodicals (Circ. No. 62, pp. 74).

Silage and Silo Construction for the South, by A. M. Soule (Farmers' Inst. Lecture No. 5, pp. 31).

CARD INDEX.

Copy for 900 cards of the index of experiment-station literature was prepared in the Office and forwarded to the Division of Publications during the year. This keeps the index as nearly up to date as has been found practicable. Some of the earlier cards, of which the supply has been nearly exhausted, have been reprinted in order to meet the increasing demand for sets of this index. The number of index cards distributed has reached 25,600. The receipts from sales of the index during the year were $317.87.

BIBLIOGRAPHICAL WORK.

The Office is cooperating with the Library in the preparation of author and subject indexes in card form to the more important articles in the leading agricultural journals. Additions have been made to the bibliography of nitrogen assimilation and to the bibliography of the nutrition of man and animals, especially as related to bread and the feeding of horses. A bibliography of the literature of plants poisonous to stock is also being prepared in the Office, and a summary of the literature of foreign investigations in veterinary science is included in the annual report of the Office for 1904. As heretofore, a list of bibliographies relating to agriculture appearing during the year has been prepared for the report of the bibliographer of the Association of American Agricultural Colleges and Experiment Stations. From time to time the Office prepares lists of references along different lines for station workers, which service has been greatly appreciated. The compilation of ash analyses of American farm products, with references to publications from which the analyses were collected, has been completed. Nearly 5,000 analyses have been collected and calculated to a uniform basis, and averages have been computed.

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The list of abbreviations of titles of scientific publications referred to on page 453 was a notable piece of bibliographical work during the year.

The collection of station publications has been continued as heretofore, and additions have been made to the sets of Department and station publications at the Alaska, Hawaii, and Porto Rico stations. A large number of foreign publications of all kinds have been received as exchanges. Many duplicates of station and other publications were received, a considerable number of which were distributed to college and station libraries and officers.

Exhibit at the Lewis and Clark Exposition.

The exhibits of this Office at the Louisiana Purchase Exposition were described in the last report of this Office. At the close of the exposition a part of the exhibit in the Government building was shipped to Portland, Oreg., and installed in the Government building at the Lewis and Clark Exposition. Dr. E. V. Wilcox, of this Office, installed the exhibit and has since remained in charge of it.

The publications of the Office and the agricultural experiment stations were shown in a case containing a set of the Experiment Station Record, the bulletins of the Office of Experiment Stations, and 600 volumes of bulletins and reports of the various experiment stations. In connection with this part of the exhibit there were also shown a card index of experiment-station literature, a map of the United States showing the location of the agricultural experiment stations, and portraits of Hon. Justin Smith Morrill and Hon. William Henry Hatch.

The work of the Alaska, Hawaii, and Porto Rico stations in developing the resources of those Territories was shown by collections of characteristic agricultural products exhibited in two pavilion cases—that of the nutrition investigations of this Office by means of typical rations, models, and vials containing various food products; and that of the irrigation and drainage investigations by means of various registers, weirs, flumes, etc., kept in operation by a stream of water maintained by an electric centrifugal pump.

Work for the Civil Service Commission.

The Director of this Office has continued to act as the general representative of the Department in matters relating to the examinations held by the Civil Service Commission for technical and scientific positions in the Department.

The number of papers received from the Civil Service Commission, recorded in this Office and rated by examiners in the Department, during the year was about 1,200, as compared with 900 last year. Besides the regular examinations, 46 special examinations were held during the year, as compared with 50 last year.

With the increasing number and complexity of these examinations the business of this Office in this line is becoming quite burdensome. The clerical work involved in recording, assigning, and transmitting the papers, and in correspondence with the bureaus of the Department and the Commission is necessarily large, and a special clerk to have charge of this business is needed.

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Insular Stations.

Considerable progress has been reported by the special agents in charge of the experiment stations in Alaska, Hawaii, and Porto Rico during the fiscal year ending June 30, 1905. Each station has extended the scope of its investigations so as to take up lines of work that seem to have an important bearing upon the agricultural development of the different countries. In Alaska the Rampart Station, on the Yukon River, was reopened and several acres of land have been cleared and are ready for cultivation. Although situated about 65° 30′ north latitude, grain has been ripened every year at this station since its establishment, in 1900. As the result of experience, a decision was reached to develop other lines of inquiry than those relating to general agriculture at Sitka and Kenai. For the future more attention will be given horticulture at Sitka and animal husbandry and dairying at Kenai. Cereal growing will be made an important feature at Copper Center and Rampart, as well as on the newly reserved tract on the Tanana River, when it becomes possible to begin work at that place. Cooperative work is still maintained at many places between the stations and settlers. Based upon the experience at the stations and with settlers, a bulletin on Vegetable Growing in Alaska has been prepared and will soon be issued.

The problem of extending our work in Alaska has become a very troublesome one. The rapid development of certain regions has led to repeated requests for a station, but it is impossible to meet these demands with the present limited income. Transportation, supplies, and labor are very expensive away from the coast, and even modest equipments cost far in excess of the ability of the station to supply them. Distances are so great and communication with other portions of the country so meager that the sphere of influence of the station is limited to a few settlements near at hand. To properly develop the resources of this country more stations are urgently needed, and the special agent in charge has repeatedly asked for greatly increased appropriations.

The Hawaii Station notes progress in that a tract of land near Honolulu has been cleared, fenced, and brought under cultivation, and a much-needed office, library, and laboratory building has been provided. In the erection of this building Territorial assistance was granted, but the amount appropriated was wholly inadequate. To complete the building and equip it made a serious inroad on the station's finances for the year. The most urgent need of the Hawaii Station is an adequate water supply for irrigation purposes and for fire protection for the station buildings. On the station grounds the rainfall varies from 30 to 120 inches, dependent upon the elevation. It is believed that the large rainfall on the upper slopes could be impounded and piped to the lower level, where water is needed for the production of all crops. The water service of Honolulu is the source of the present supply, and for irrigation purposes it is very precarious, and does not offer any fire protection. The experimental work of the station is noted elsewhere. A visit was paid this station by the chief of the Division of Insular Stations during the year, and his report indicates that good progress is being made in its work.

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The Porto Rico Station, without curtailing the other investigations, has taken up field operations with rice and other crops and is paying especial attention to the methods of culture and to the use of fertilizers. The experiments that have been in progress with coffee are beginning to show results. It has been found by cultural methods that it is possible to more than double the average production of the trees. Some investigations have been begun in animal husbandry that it is hoped will lead to the improvement of the live stock on the island. On account of the expense only a limited number of animals will be secured at present, but they will be added to as funds permit.

As during the previous seasons, all the stations have carried on more or less cooperative work with this Department, and especial acknowledgment is made to the Bureau of Plant Industry for its generous cooperation in furnishing seeds for distribution and trial in Alaska and tropical economic plants for Hawaii and Porto Rico.

The income of the stations was $15,000 each from the Federal Treasury, and this sum was augmented by sales funds that, by act of the Congress, are made available for use at the stations where produced. The additional funds for each station during the past year were: Alaska, $260; Hawaii, $1,153, and Porto Rico, $1,013.

The work of the Washington office in connection with the insular stations continues to increase as their operations are extended. This business, as hitherto, has been in charge of Dr. Walter H. Evans, as chief of the Division of Insular Stations.

ALASKA EXPERIMENT STATIONS.

The Alaska stations have been in charge of Prof. C. C. Georgeson as hitherto. The extremely unfavorable weather conditions that prevailed along the northern Pacific coast during the summer of 1904 were extended to and throughout Alaska. The unusual low temperature, continued cloudy weather, and abundant rain resulted in many crop failures at the stations and also among the stations' cooperators. In many instances the crops made little growth, and at the stations away from the coast where they did grow they were severely injured by early frost. While the results were discouraging to a great degree, it was possible to gain a knowledge of the hardiness of certain varieties that will doubtless prove of inestimable value. At Copper Center a number of varieties of oats and barley matured and made heavy crops, showing their peculiar adaptability to the region, while others were unable to mature under the adverse conditions. Similar results are reported for certain garden crops, and on the whole it can be safely asserted that varieties that successfully matured during 1904 will be adapted to almost any season to be expected. At Rampart Station, latitude 65° 30′ north, oats and barley matured as they have done every season since the work was begun at that point. No cereals matured at the Sitka or Kenai station. The net result of the past season's work has made it possible to more sharply differentiate the lines of investigation at different stations.

Sitka Station.—Attempts to grow cereals will be abandoned and attention turned to horticultural investigations along a number of lines. Previous experiments have shown the value of the use of lime and fertilizers on the raw acid soils of Alaska, and these inves-

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tigations will be continued to determine the most economical treatments required. Variety tests of cabbage, cauliflower, and potatoes are being carried on, 76 varieties being under observation for adaptability. Comparisons are also being made to determine the relative value of station-grown and Minnesota seed potatoes, the preliminary results being in favor of the station-grown seed. A nursery of apples, cherries, plums, currants, raspberries, gooseberries, strawberries, and hardy ornamentals has been established, the object being to test and distribute these plants as widely as possible. The apples are mostly of the early maturing Russian varieties and crab apples that mature in the more northern States. A considerable number of the fruit trees are making good growth, and 137 requests have been received for trial lots for planting in different parts of the country. Quite a number of successful grafts have been made of Russian and crab apples upon the common wild crab of Alaska, and the growth made is very promising. The erection of a small forcing house has made it possible to undertake some plant-breeding experiments, and a successful cross between the wild salmonberry and the cultivated red raspberry is announced. Experiments in crossing wild and cultivated forms of the strawberry, cranberry, etc., have been begun, and the work along this line will be continued.

Most of the live stock, except the fowls, has been sold or transferred to some of the other stations, so that the experiments along this line will be suspended for a time.

A cooperative experiment in apiculture with the Bureau of Entomology of this Department is being carried on with promising results. Two colonies of bees were furnished the station by the Bureau of Entomology, together with seed of a number of bee-food plants. With a few exceptions the seed failed to germinate, but the bees seem to have found an abundance of flowers and it seems probable that they will succeed well.

Kenai Station.—The failure to mature grain at this station has been mentioned, but the experience thus far obtained has shown the possibility of the growing of almost unlimited quantities of grain hay. The question of animal husbandry will be given serious consideration at this station. There are now 13 head of cattle at this station, all of which came through the winter in fine condition. There are about 30 acres under cultivation at Kenai, and with this area to supply winter forage the station will give particular attention to developing the possibilities of dairying in Alaska. A small equipment of dairy apparatus has been forwarded to the Kenai Station and the practicability of commercial dairying, it is hoped, will soon be demonstrated. There are large areas similar to the region about Kenai, and if this experiment proves a success a promising new industry will be added to the country.

Copper Center Station.—At this station some advance is reported in the way of clearing land, construction of buildings, equipment, etc. The season of 1904 began very auspiciously, but later the cold, cloudy weather set in, and while the growth of crops was luxurious, the ripening of grain was retarded. Much injury was done by frosts during August, the temperature falling one night to 24° F. In spite of these adverse conditions several varieties of oats and barley matured an average crop. Sixty Day and Black Finnish oats and some of the

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plats of Manshury barley matured their grain. The other cereals were all cut as grain hay, the yield of forage in some cases being more than 2 tons of cured hay per acre. An experiment had been begun to test the value of fertilizers when applied to the soil, and where 500 pounds of fish guano was applied per acre the weight of hay was 3 to 4 times as great as where none was used.

The experiments with grasses and forage plants were continued and many of the grasses showed that they were well adapted to the conditions at the station, timothy, blue grass, and meadow foxtail maturing seed and others making splendid growth for pasture. The season was too cold for all the clovers. The garden suffered from the effect of the cold weather, though many varieties did fairly well.

The beginning of the season 1905 was very flattering. All the fall-sown grain came through the winter in fine condition and the spring seeding was all finished by May 25. There was a slight deficiency of rainfall during June, but otherwise the outlook was very promising. A cow and calf were shipped to the station from Sitka, adding to the live stock equipment and also contributing to the comfort of the superintendent and his family.

RAMPART STATION.—This station, which is situated on the Yukon River, several hundred miles from its mouth, was established in 1900, but was temporarily abandoned by the resignation of the agent in charge in 1901. It was reopened the past year, and Mr. F. E. Rader, for a number of years at the Sitka Station, was placed in charge. This station is one of the most northerly experiment stations in the world, if not the most northerly, yet every year it has been in operation cereals have ripened, and the quality of the grain is unsurpassed. Encouraged by the past results, it has been thought desirable to extend our operations, and there are now 5 acres of land ready for cultivation. The station is sadly in need of buildings, work animals, and other equipment, but with the limited appropriations the development will have to be slow. A recent report from Rampart says that the fall-sown grains came through the winter in fine condition and the spring-sown crops were making excellent growth.

During the past year an investigation was carried on by cooperative agreement between the Alaska stations and the Bureau of Plant Industry of this Department. Under this agreement Mr. C. V. Piper, then connected with the office of the Agrostologist, visited Alaska, journeying along the coast from Sitka to Unalaska and examining into the range possibilities of the country. A report was prepared of his observations and printed in the Annual Report of the Office of Experiment Stations for 1904. The possibilities of this region for dairying and stock raising are pointed out, the writer thinking there are excellent localities for dairy colonies.

As in the past, the Bureau of Plant Industry of this Department has liberally cooperated with the stations in supplying seeds of various kinds. These were sent not only to the experiment stations for testing, but to over 2,000 addresses furnished by the special agent in charge. Those connected with the Alaska experiment stations wish to record their appreciation of these favors. By this distribution of seed it is possible to plant hundreds of gardens that would otherwise not be planted on account of the inability to obtain seed of varieties adapted to the regions. The presence of many gardens throughout Alaska, which serve to improve the conditions of life, may

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be traced directly to the seed distribution of the Bureau of Plant Industry through the experiment stations. The cordial cooperation of the Bureaus of Chemistry and Soils is also acknowledged.

Acting upon the request of the Secretary of Agriculture, the Congress at its last session appropriated $3,000 for the purchase and introduction of live stock for experimental purposes. As this fund was not available until July 1, 1905, it was believed best to defer its expenditure until the spring of 1906. This will avoid the necessity of wintering the stock and enable the stations to prepare for them and to arrange for their purchase and shipment. The sum will be spent in securing Galloway and other hardy races of cattle, and possibly some sheep and goats. In order to properly follow up this experiment, appropriations for this purpose should be continued. It is confidently expected that success will follow this experiment, and the policy of the Government in the introduction of reindeer will warrant the continuation of the small additional amount needed for the purchase and care of live stock.

HAWAII EXPERIMENT STATION.

During the fiscal year ending June 30, 1905, the investigations at the Hawaii Experiment Station were along the same general lines as described in previous reports, and the work has continued to be in charge of Mr. Jared G. Smith. Considerable building was done during the year, and in addition to laborers' quarters there are houses for the special agent in charge, the chemist, and the entomologist. A much-needed office and laboratory building has been provided, and as it is practically fireproof the library and more valuable equipment of the station are safely housed for the first time. The station was badly cramped in its work by the necessity of the use of a considerable portion of its funds in building operations. The Territorial legislature of Hawaii appropriated $1,500 toward a residence for the chemist and $3,000 for a fireproof library, office, and laboratory building. The wording of the act was such that in order to secure these appropriations it became necessary to add about $3,000 of the station's funds to complete the buildings. Two new 10,000-gallon water tanks were erected and the water system extended and increased by the substitution of nearly 1,000 feet of 3-inch pipe for the previous 2-inch main connecting with the city water supply. Even with this larger pipe the supply of water for irrigation purposes is uncertain, as the city water supply is limited and the station is liable to be cut off in case of threatened scarcity.

Among the lines of investigation at the station the special agent has given attention to grasses and forage plants, tobacco, coffee and cane diseases, tanbark production, etc. In cooperation with the Hawaii Live Stock Breeders' Association about 700 pounds of seed of grasses and other forage plants were secured and distributed. Sufficient time has not yet elapsed to determine the success of this experiment, but already it has been shown that fenugreek, Spanish sulla, woolly top (*Andropogon saccharoides*), and *Panicum bulbosum* are adapted to Hawaiian conditions. These recent introductions, together with others previously brought in by the station, are recognized by stockmen as having been of great value in restocking and extending the ranges. This work will be continued.

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A tract of about 6 acres of black wattle (*Acacia decurrens*) was cut and the bark stripped for tanbark. This grove was planted in 1890 by the Government, but it had received no attention. The trees were crowded, overmature, overrun with lantana, and many were dying, about 10 per cent having died during the past year. The ground where the trees stood is rocky and quite steep, and although the stripping was difficult on account of the age of the trees and the extended drought prior to cutting, yet 33 tons of tanbark, worth $25 per ton in Honolulu, and 100 cords of wood, worth $7 per cord, were obtained. Analyses of the bark showed that it contained from 29 to 36 per cent tannin, and if sold according to analysis should have brought about $30 per ton. The special agent believes the cultivation of wattles in Hawaii can be made very profitable on lands not adapted to any of the present staple crops, if proper attention be paid to planting, care, and harvesting.

A cooperative experiment with tobacco in Hamakua, Hawaii, has been begun, and the success attending the first year's work has led to additional experiments in other localities. Many varieties of seed were obtained from different sources and the product grown was submitted to commercial and other experts, who reported very favorably upon some of the samples. It seems established that cigar tobacco of good quality can be grown in Hawaii, and if the successes of last year are repeated this season another important industry will be added to Hawaii's agriculture through the investigations of the station.

Recently considerable interest has been aroused in Hawaii in the cultivation of rubber trees. The station is actively engaged in investigating the subject and has issued a circular giving in a condensed form what information was available regarding rubber culture and the most promising varieties for Hawaii.

The horticultural investigations have been along the enlargement of the collections of economic plants at the station and the studying of specific problems of different fruits. The cacao experiment at Hilo has been continued, the station now having 1,000 trees planted on leased land belonging to the Hilo boarding school. The experiment with Bluefields bananas described in the previous report has been continued, and in addition to testing this variety for export purposes investigations are being carried on on methods of culture, fertilizing, etc. Collections are being made of the most valuable so-called native bananas and also of the numerous citrus seedlings on the different islands of the group. An especial effort will be put forth to develop some of the better citrus seedlings and to reestablish the growing of these fruits on a commercial scale. A cooperative experiment with this Department was made in the autumn of 1904 in the shipment of avocado pears, testing methods of packing, effect of cold storage, etc. The experiment was begun so late that only the last crop was available and the fruit was not in the best shipping condition. Nevertheless of five lots, two arrived in New York in good condition and one was perfect and brought high prices. The experiment is to be repeated this year.

The chemist had to devote considerable time to fitting up the new laboratory. In addition analyses of 63 samples of Hawaiian forage plants have been made, and besides the usual analysis determinations were made of proteid nitrogen, phosphoric acid, potash, and lime. A large number of miscellaneous analyses have been made, including

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soils, fertilizers, honey, guava jelly, canned pineapples, condensed milk, etc. Research investigations have been continued on the organic nitrogen of Hawaiian soils and its nitrification. During May and June the chemist made for the Nutrition Investigations of this Office dietary studies with some of the food materials not included in the ordinary dietaries of the mainland. The chemical department is in need of a better gas supply, either by connection with the city gas service or by the purchase of a larger gas machine. Connection with the city supply would involve the laying, at the station's expense, of several hundred yards of pipe from the laboratory to the nearest approach of the gas mains.

The entomologist, in addition to attending to a large and growing correspondence, is extending the collection of economic insects and gathering data regarding their distribution. Investigations are being carried on on forest insects, especial attention being paid to the insect enemies of the algarroba and black wattle. Some experiments in bee keeping and silkworm raising have been begun. Experiments on rearing silkworms were carried on during the past year, the station breeding and carrying to maturity more than 20,000 silkworms. The quality of silk produced has been pronounced equal to the best Japanese grades, and it is believed that silk production as an industry for large families is entirely practicable and would prove profitable. A survey of the Territory is being made to determine the distribution of the cane leaf hopper as effected by exposure, altitude, temperature, rainfall, methods of culture, etc. In connection with a local board the entomologist is aiding in the mosquito campaign, much of the work being due to the personal efforts of the entomologist. The entomologist prepared a bulletin on the insect enemies of tobacco in Hawaii as a sort of warning to prospective tobacco growers and also giving the most approved methods of combating the pests.

Farmers' institutes have continued to be held under the auspices of the station, although the small appropriation by the Territorial legislature for their support was withdrawn.

Since the last report the station has issued or prepared for printing the following publications:

Bulletin No. 7.—The Banana in Hawaii.
Bulletin No. 8.—Methods of Milking.
Bulletin No. 9.—Citrus Fruits in Hawaii. [In press.]
Bulletin No. 10.—Insect Pests of Tobacco in Hawaii.
Press Bulletin No. 10.—The Pineapple Scale.
Press Bulletin No. 11.—The Common Liver Fluke in Hawaii.
Press Bulletin No. 12.—Tobacco Experiments in Hamakua.
Press Bulletin No. 13.—Rubber in Hawaii.

PORTO RICO EXPERIMENT STATION.

The work of the Porto Rico Station has been continued along the lines laid down in previous reports, and has been in charge of Mr. D. W. May. The conditions for experimentation have in general been favorable and much progress is reported. The station has lost the services of Mr. O. W. Barrett by transfer to the Bureau of Plant Industry of this Department. Mr. Barrett had been botanist and entomologist of the station since the organization of the station staff, but he was compelled to leave Porto Rico on account of his health,

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and the vacancy has not yet been filled. An appointment will be made as soon as a competent man can be secured. It is proposed, in filling this vacancy, to depart somewhat from the previous lines and to secure a plant pathologist, who can study the causes of a number of diseases of economic plants and endeavor to find means for combating them. Miss Jessie F. Springer, clerk and stenographer, returned to the Department during the year, leaving the position vacant.

The old plantation purchased by the insular government for the use of the experiment station has undergone extensive changes. Buildings have been repaired, fences built, and the lowlands drained. About 80 acres are now under cultivation and more land will be planted as the necessity for experiments and means justify. The pioneer work having been nearly completed, it will now be possible to devote to experimental purposes the funds formerly used for clearing, fencing, etc. The policy of continuing the services of competent labor has been justified, as the laborers have become more efficient and require less constant supervision than formerly. A tract of about 7 acres adjoining the station, formerly the agronomic station under Spanish rule, has been turned over to the station for its use.

The insular legislature at its last session did not appropriate any funds for the support of the station. This, it is said, was not due to any lack of interest or appreciation, but to a deficiency in revenue. The legislature did enact some legislation in which the station is concerned. A seed and plant inspection law and a fertilizer law were passed. In the former the station is charged with the inspection, while in the latter the station acts in an advisory capacity. The seed and plant inspection law is limited to the inspection of coffee, cotton, and citrus fruit trees, and on account of the fact that many parasites occur on a large number of species of plants the law should be made to include all importations. Cane, cacao, rubber, and other economic plants should be protected as well as those mentioned in the law.

The experimental work in horticulture continues to occupy first rank in the station's operations. The plantings of citrus fruits, cacao, and rubber will be continued and extended. An experiment will be begun in planting an orchard of citrus trees in a small valley already covered with native forest trees. It is believed that the conditions of moisture found under the partial shade that is to be maintained will result in a more active growth of fungus parasites of the scale insects of oranges, etc., and thus render spraying unnecessary. Comparisons will be made with an orchard on cleared ground kept well cultivated. Investigations with mangoes and pineapples will be continued. Attempts will be made to propagate the better varieties of mangoes as rapidly as possible, cooperation with the Bureau of Plant Industry of this Department being maintained to secure improved varieties of mangoes and other plants. The pineapple industry seems to be developing rapidly in Porto Rico, and experiments with varieties, methods of planting, and use of fertilizers will be continued. Attention will be given the introduction of other economic fruits that seem promising for Porto Rico. The experiments with bananas, yautias, cassava, yams, and other plants that now furnish the larger part of the food of the people of Porto Rico will be continued, particular attention being given the subject of adaptation,

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culture, and use. Continued efforts in vegetable growing have resulted in splendid success with crops that were heretofore failures, and a bulletin on vegetable growing is in course of preparation. The success is attributed to the extensive use of fertilizers and thorough tillage. A limited experiment with tobacco is being carried on at Mayaguez this season, the object being to study some of the phenomena of fermentation, testing in a practical manner some of the discoveries of Doctor Loew while connected with this Department.

Trials under field conditions are being made with rice, corn, cane, and on smaller plats with various leguminous crops. Lowland rice has not been formerly grown in Porto Rico, and it is believed possible to grow a large proportion of the supply of this cereal, practically all of which is now imported.

The coffee experiments at La Carmelita will be continued under the same conditions as formerly. Some of the varieties imported through the station will fruit this year, and some indication of their value will be gained. The experiments with the native coffees and the improved method of culture have proved highly successful. Some trees on the experimental tract have yielded more than double the quantity obtained from average trees from other portions of the plantation.

With a view to extending lines of investigation the station has purchased, through the special agent, a saddle-bred stallion. Experiments with animals have long been thought desirable, and the special agent will begin some breeding investigations. In addition, the station has acquired some pigs and will soon buy a few chickens for experimental purposes. Through the station an attempt is being made to interest the planters and others in improved breeds of cattle, and during the year three head were placed on plantations. The stock shipped in have created a favorable impression, and it is believed that more attention will be given in the island to animal production than formerly.

The investigations at the station have progressed to a stage when it seems almost essential that a chemist should be added to the staff. Many problems in connection with the use of fertilizers are coming up, and in many ways a chemist could supplement the work of the other members of the staff. It is hoped that means will be found during the ensuing year to engage a chemist and to equip a small chemical laboratory.

Following up previous efforts along the same line there was organized an agricultural society, of which Mr. Henricksen, horticulturist of the station, is secretary. Under the auspices of this society farmers' institutes will be held, several meetings in different parts of the island having been arranged.

During the fiscal year English and Spanish editions were issued or prepared for the printer of Bulletin No. 5, Tobacco Investigations in Porto Rico During 1903–4; Bulletin No. 6, The Yautias, or Taniers, of Porto Rico, and Circular No. 5, Coffee Growing in Porto Rico.

Nutrition Investigations.

The investigations with reference to the food and nutrition of man, carried on under the auspices of the Office of Experiment Stations, have been conducted on very much the same general lines during the

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fiscal year ending June 30, 1905, as in previous years, new experiments being undertaken whenever the finishing up of any line offered the opportunity.

OBJECT AND NATURE OF THE INVESTIGATIONS.

The chief object of the investigations is to find out the fundamental laws of nutrition and the practical application of these laws to the health and well-being of man. Particular attention is given to the physiology, hygiene, and economics of nutrition, with special reference to improving the diet of people living under different conditions of age, sex, work, climate, etc.

The inquiry in the past has been devoted to four general classes of investigations: Cooking experiments, dietary studies, digestion experiments, and experiments with the respiration calorimeter, and these lines of work have been continued the past year.

In the cooking experiments, the especial purpose has been to study the changes and losses resulting from different methods of cooking, and their influence upon the digestibility and nutritive value of the food materials studied. This year the investigations have been concerned particularly with meats, beef, veal, mutton, and pork being used from animals reared and fattened under known conditions.

During the period in which the nutrition investigations have been carried on under the Department of Agriculture, a large number of dietary studies have been made with many classes of people, of different ages, sex, and occupation, in many different parts of the country, and living upon a varied food supply. In this way a considerable amount of data has been collected regarding the kinds, amounts, and cost of food materials used by the people in different parts of the country under widely varying conditions. These data have proved useful for comparison with the results of similar investigations in this and other countries and have been of value in establishing general dietary standards. The dietary studies this year have been carried out with people of limited means and a restricted diet living in the mountain districts of Tennessee. Dietary studies have also been made at the Hawaiian Agricultural Experiment Station with the family of a professional man and with native students, and at the Bayview Asylum, Baltimore, Md., an institution whose inmates are quite largely the aged poor of both sexes.

In order to obtain data regarding the digestibility of different food materials and to determine the proportion of consumed material which is made use of by the body, digestion experiments have always been an important part of the nutrition work. The data accumulated have been used to establish standard factors or coefficients of digestibility. During the last fiscal year digestion experiments have been made with cereals, legumes, fruits, and nuts. Some work has also been done with a view to learning how thoroughly the ash constituents of food are assimilated and utilized.

The investigations with the respiration calorimeter for the past year have been devoted quite largely to studies of the effect of severe muscular exercise and of mental work upon the output of carbon dioxid and heat, and the intake of oxygen. The subject for the first series of experiments was a professional bicycle rider, and for the latter several college students. In addition, a considerable number

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of short experiments were made to study the normal carbon dioxid and heat output of different individuals of varying physique.

As in the past, the results of the investigations have been prepared for publication, and in addition many teachers, students, and specialists have been supplied by correspondence and in other ways with information and data which were not accessible in printed form.

The work of the nutrition investigations has been principally carried on in cooperation with educational, scientific, and charitable organizations in different parts of the country, but the Office of Experiment Stations has had the general supervision of the enterprise and some important details of the work have been conducted at the Washington office.

WORK AT THE WASHINGTON OFFICE.

In addition to editorial work, the Washington office has had a general supervision of the plans and expenditures of the nutrition investigations during the past year, and in cooperation with the collaborators has made detailed plans for the various experiments which are undertaken. The collection of bibliographical data relating to nutrition has been continued, as well as the preparation of abstracts and reviews of current literature of the subject, partly for use in the Experiment Station Record and partly for such other purposes as seemed desirable in connection with the general inquiry. The increase in correspondence, the growing demand for nutrition publications, and the large number of requests for lectures and informal talks on these subjects indicate that the popular interest in the work is growing. The nutrition work of the Washington office has been in charge of Dr. C. F. Langworthy.

COOPERATING INSTITUTIONS AND INVESTIGATORS.

The institutions at which the cooperative investigations have been conducted during the past year and the various investigators were as follows:

California: University of California, Prof. M. E. Jaffa and associates.
Connecticut: Wesleyan University and Storrs Agricultural Experiment Station, Prof. W. O. Atwater and associates.
Hawaiian Islands: Hawaii Agricultural Experiment Station, Prof. Edmund C. Shorey.
Illinois: University of Illinois, Prof. H. S. Grindley and associates.
Maine: University of Maine, Prof. C. D. Woods and associates.
Maryland: Baltimore Board of Charities, H. A. Pratt and C. F. Langworthy.
Minnesota: University of Minnesota, Prof. Harry Snyder and associates.
New York: Columbia University, Dr. H. C. Sherman.
Tennessee: University of Tennessee, Prof. C. E. Wait and associates.

THE COOPERATIVE INVESTIGATIONS.

The cooperative investigations carried out the past year in detail are as follows:

CALIFORNIA.

The nutrition investigations at the University of California, carried on by Prof. M. E. Jaffa and associates, were a continuation of those begun the previous year. The digestibility of fruits and nuts and their nutritive value when forming a part of a mixed diet were

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studied, as well as the amounts which are consumed under a variety of circumstances, with a view to learning how thoroughly these important foods are utilized in the body, and their relative value in the diet. The importance of the fruit and nut industry in California and the great variety obtainable in that section make the University of California a particularly favorable place for these investigations. Professor Jaffa has been especially fortunate in obtaining subjects for these experiments.

In connection with the investigations Professor Jaffa has made nine digestion experiments, including studies of the income and outgo of nitrogen, for the purpose of ascertaining the digestive coefficients of fruit and nuts in a mixed diet. He has also devoted some time to tabulating and editing the results of thirty-five metabolism experiments and two dietary studies previously conducted. The results of all these investigations, it is expected, will be ready for publication in a short time.

CONNECTICUT.

Owing to the serious illness of Professor Atwater, which developed in the early winter, the planning and direct supervision of the cooperative investigations was for a considerable part of the year in charge of the Washington office. The experimental work with the respiration calorimeter and the other special investigations at Middletown have been carried on under the direction of Prof. Francis G. Benedict, Professor Atwater's associate, who has for some years been more immediately in charge of the work.

In addition to the amount set aside by the Department of Agriculture for the investigations at Middletown, the Storrs Agricultural Experiment Station has contributed a part of an appropriation from the State of Connecticut, intended for use in such special investigations. Wesleyan University has also continued to contribute the use of its laboratories and other facilities for the same purpose.

The Carnegie Institution of Washington has continued grants for research, by which apparatus has been developed for use in connection with the respiration calorimeter, making possible the determination of the income and outgo of oxygen, and a number of metabolism experiments have been made with the improved apparatus, both for the Office of Experiment Stations and the Carnegie Institution. As Professor Atwater was ill, the grant was made this year to Doctor Benedict, and was used especially to determine the income and outgo of oxygen during fasting.

INVESTIGATIONS WITH THE RESPIRATION CALORIMETER.—The two main questions studied by this Office during the last fiscal year have been the effect of severe muscular exercise and of mental work on the output of carbon dioxid and heat and on the intake of oxygen. For the first series of experiments a professional bicyclist was secured, who spent from two and one-half to six and one-half hours inside the respiration chamber for portions of eight days at severe muscular work on the bicycle ergometer. During the experiments not only was the total amount of heat, water, and carbon dioxid accurately measured, but also the amount of oxygen consumed, as well as the amount of external work expended on the pedals of the machine. From the data thus obtained the mechanical efficiency of the body may be computed.

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The subjects for the experiments on mental work were students of Wesleyan University. Each of these subjects took some of the mid-year examinations in the respiration chamber, spending there a period of not less than three hours per day. Candidates of varying degrees of ability were selected and the nature of the work done was varied as much as possible. For purposes of comparison a control experiment was made with each student in which the subject passed the same period of time in the respiration calorimeter chamber as in the previous experiment, and passed the time without mental work of any special kind or amount.

A considerable number of experiments were also made to study the normal carbon dioxid and water output and energy requirement of individuals of different physique. Among the subjects were two tall, thin young men, both over 6 feet in height. Five experiments of this nature were also conducted with women. Experiments such as these are admirably adapted for showing the normal physiological factors for energy, water and carbon dioxid output, and oxygen requirement of different individuals, and will furnish data for establishing certain definite standards based upon weight, sex, height, and general physique.

Such factors must be taken into account in accurately determining the amount of nutrients and energy required for maintaining the body and for enabling it to perform a definite amount of work of any given kind, and also for fixing upon dietary standards showing the amounts of food required to maintain the body in the highest state of health and efficiency.

A large number of experiments to calibrate the bicycle ergometer have been made, which give valuable data for use in discussing the question of the method of measuring external muscular work.

In the fall of 1904 a number of important changes and improvements were made in the respiration calorimeter. The interior arrangements have been modified to secure greater convenience and the pump formerly used for maintaining the ventilating air current has been advantageously replaced by a rotary blower immersed in oil. A new balance has been installed in the chamber and carefully tested. With this it is possible to weigh the large water absorbers and also the subject of the experiments while he is still in the chamber as often as is desired. The enameled iron vessels which have previously been used to contain strong sulphuric acid through which the air current was caused to pass have proven unfitted for the purpose and have been replaced by vessels made of pottery, which are found to be comparatively satisfactory.

GENERAL WORK.—A considerable amount of editorial work is carried on at Middletown, including calculations, verifications of results obtained in the cooperative investigations, the collating of results of the work of other investigators, and the preparation for publication of the results of the experimental work at Middletown and at cooperating institutions. The tabulation of the results of the dietary studies made in connection with the nutrition investigations, referred to in last year's report, has been continued this year as opportunity offered. This work has been in charge of R. D. Milner.

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HAWAIIAN ISLANDS.

Dietary studies have been conducted at the Hawaii Agricultural Experiment Station, under the direction of Dr. Edmund C. Shorey, in the family of a professional man and with pupils of a native school. The results of these studies will prove of especial value as they have been made with residents of the Tropics, a class of people not previously studied in the Department investigations. Furthermore, some of the food materials used have not been included in previous work of this nature.

ILLINOIS.

The investigations with meat at the University of Illinois, in charge of Prof. H. S. Grindley, have been conducted under very favorable conditions. The university has furnished the use of an especially well-equipped laboratory, and, in addition, contributed a considerable sum toward the nutrition investigations. The meat used in the investigations was contributed free of cost by the Illinois Experiment Station, and the animals from which the material was taken were bred, grown, and fattened under known conditions. The department of household science of the university has also rendered valuable assistance in the investigations. Beef, veal, mutton, and pork were the meats studied.

Professor Grindley and his associates conducted forty-five cooking experiments during the past year. In these experiments the inner temperature, flavors, losses, and other changes resulting in the boiling, roasting, frying, broiling and sautéing, also the influence of covered and closed pans upon the above processes, were determined, as well as the effect of these factors upon the digestibility and nutritive value of the meat. Some of the experiments also included the influence of salt in varying quantities upon the losses, changes, and modification of flavors which meats undergo during the process of boiling. In addition to the cooking experiments, twelve experiments were carried out to determine the relative toughness and tenderness of raw and cooked meats by means of a special machine which Professor Grindley has recently perfected.

MAINE.

Prof. C. D. Woods, at the University of Maine, has made thirty digestion experiments with cereal breakfast foods, the investigations being intended to form a part of the general investigation of the food value and relative importance of cereal foods of different kinds carried on at the universities of Maine and Minnesota. Professor Woods has been studying in particular the breakfast foods made from oats, wheat, and corn, and has also made studies of the metabolic products of feces. The special object of the work is to secure information regarding the effect of different methods of manufacture on the nutritive value of cereal breakfast foods, the relative amount of nutrients supplied by different sorts for a given sum, and the food value of the class of goods as compared with bread.

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MARYLAND.

In cooperation with the Baltimore board of charities a series of dietary studies was conducted in the spring of 1905 at Bayview Asylum, Baltimore, Md., by H. A. Pratt, of the Middletown office, and Dr. C. F. Langworthy, of this Office. The greater number of the persons included in the study were aged men and women. Hitherto, data have been lacking regarding the amounts eaten under such circumstances, and the results are of great value. Much information has been obtained of importance in discussion of the economical arrangement of institution dietetics and which is useful in other ways. In connection with the work studies were made of the digestibility of a simple mixed diet by aged men.

MINNESOTA.

As in the past, the investigations at the University of Minnesota under Prof. Harry Snyder have been made with cereals, being carried out in conjunction with those made at the University of Maine under Professor Woods. Professor Snyder has made twenty-four digestion experiments with men of four days each, with eight different kinds of cereal breakfast foods, to determine their relative digestibility.

Professor Snyder also continued the experimental work with durum wheat, conducting one milling experiment, and six digestion experiments of four days each with men, for the purpose of determining the digestibility of macaroni and breakfast foods prepared from durum wheat.

NEW YORK.

Dr. H. C. Sherman, of Columbia University, has continued the collating of material regarding protein protection, which has been in progress for a year or more, and has begun studies of the nutritive value of the ash constituents of food with a view to fixing upon values which will show the amount of the different important mineral constituents of food required per man per day under various circumstances.

TENNESSEE.

Prof. C. E. Wait, of the University of Tennessee, at Knoxville, made six digestion experiments of four days each, three with a basal ration and three with a ration including legumes. In addition, Prof. A. F. Gilman, under the supervision of Professor Wait, has conducted twenty dietary studies in typical families of white people of limited means, especially those living in mountain districts. The digestion experiments continue earlier work on the nutritive value and digestibility of beans, peas, and other legumes, one of the very important groups of foods especially rich in vegetable protein.

The dietary studies are of value in fixing upon dietary standards, as the groups studied live upon very simple rations.

MISCELLANEOUS.

In connection with the nutrition work Professor Atwater made several addresses, during the early part of the fiscal year, on the scope and results of the nutrition investigations. In addition to the two delivered at the British Association for the Advancement of

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Science, in Cambridge, England, and the Sixth International Congress of Physiologists, Brussels, Belgium, referred to in last year's report, he presided over the section of physiological chemistry at the International Congress of Science and Art, at St. Louis, and later addressed at St. Louis the directors of the Millers' National Federation on the "Nutritive value of milling products of wheat and other cereals."

PUBLICATIONS.

Since the nutrition investigations were first undertaken forty-nine technical publications have been issued and twenty-five popular bulletins and similar articles. Abstracts of nutrition investigations have also appeared regularly in the Experiment Station Record and numerous popular summaries in the series of Farmers' Bulletins entitled Experiment Station Work.

The food and nutrition publications the past year have included three technical bulletins, one Farmers' Bulletin, an article for the Yearbook of the Department and one for the Annual Report of the Office for 1904, and also extensive revisions of three of the Farmers' Bulletins previously issued.

The publications were as follows:

Studies of the Food of Maine Lumbermen, by C. D. Woods and E. R. Mansfield. (Bul. 149, pp. 60.)

This bulletin gives the results of five dietary studies and six digestion experiments with men engaged in severe manual labor in the Maine lumber camps. The data obtained from the dietary studies will be of service in the calculation of dietary standards. With a very few exceptions, these dietaries are the highest yet recorded as regards protein and energy for any class of American laboring men. The results of the digestion experiments taken as a whole agree quite closely with the average values obtained in a large number of American experiments made under widely varying circumstances, and furnish data with reference to the digestibility of a mixed diet and the effect of severe work upon the quantity of nutrients assimilated. According to the digestion experiments, animal foods furnished 33 to 50 per cent of the protein and 20 to 50 per cent of the energy of the diet, while 20 to 30 per cent of the total protein and from 10 to 14 per cent of the energy of the diet was furnished by baked beans.

Dietary Studies at the Government Hospital for the Insane, Washington, D. C., by H. A. Pratt and R. D. Milner. (Bul. 150, pp. 170.)

The investigations reported in this bulletin cover twenty-six studies, four of which were made with officers and attendants at the Government Hospital for the Insane, and the remainder with patients. The principal features of the investigation had to do with the study of the quantities of food consumed and wasted by different classes of hospital population. The results of this inquiry furnish data for use in determining dietary standards and also have a decided practical value, since it has been possible to make many improvements in the institution diet through the knowledge gained in these studies.

Dietary Studies with Harvard University Students, by Edward Mallinckrodt, jr. (Bul. 152, pp. 63.)

This publication reports the results of a number of dietary studies made at one of the students' boarding houses at Harvard University.

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They are of especial interest for their bearing upon dietary standards for students and others of sedentary occupation and because they seem to show that some of the student boarders were living and working creditably upon a daily ration considerably below the accepted standards for men of sedentary habits.

Canned Fruit, Preserves, and Jellies; Household Methods of Preparation, by Maria Parloa. (Farmers' Bulletin No. 203, pp. 31.)

This bulletin is a popular presentation of the subject indicated by the title, prepared especially for the use of housekeepers. It gives an eminently practical summary of available information regarding the household methods of canning and preserving domestic fruits, as well as the results of much original work by the author.

Investigations on the Nutrition of Man in the United States, by C. F. Langworthy and R. D. Milner. (Document No. 713, pp. 20, pls. 6.)

A descriptive pamphlet prepared primarily for distribution at the exposition at St. Louis.

The Respiration Calorimeter, by W. O. Atwater and F. G. Benedict. (Yearbook of Department of Agriculture for 1904, pp. 16.)

A popular description of the respiration calorimeter and method of operating it is given in this article, and some of the experimental results obtained are briefly outlined.

Dietetics in Relation to Hospitals for the Insane, by W. O. Atwater. (Annual Report of the Office of Experiment Stations for the year ended June 30, 1904, pp. 23.)

This article gives a brief summary of the results of different studies in hospitals for the insane carried on under the direction of the author, with a discussion of their practical application to dietetics in these institutions.

In addition, two technical bulletins were prepared for the printer:

Studies on the Digestibility and Nutritive Value of Bread and of Macaroni, 1903–1905, by Harry Snyder. (Bul. 156, pp. 80.)

A Digest of Japanese Investigations on the Nutrition of Man, by Kintaro Oshima. (Bul. 159, pp. 224.)

Two technical bulletins giving the results of Professor Grindley's investigations on meat at the University of Illinois, a Farmers' Bulletin on Cereal Breakfast Foods, and one on The Guinea Fowl and Its Use as Food were also prepared for publication, and Farmers' Bulletins 85, Fish as Food; 121, Beans, Peas, and Other Legumes as Food; and 128, Eggs and their Uses as Food; and Circular 46, Functions and Uses of Food, were revised.

RESULTS OF NUTRITION INVESTIGATIONS.

Some of the more important deductions which may be drawn from the recently reported results of the nutrition investigations should be cited.

The studies carried on in California have demonstrated the fact that raw fruits and nuts may furnish a considerable proportion of the total nutrients of the diet at a reasonable cost, and that these foods should be regarded as staple articles of diet and not as food accessories.

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A large number of tests by the Maine and Minnesota experiment stations indicate that it is as true of all classes of wheat as of the considerable number studied that white bread furnishes the body with more protein and energy, pound for pound, than whole-wheat or Graham bread made from flour ground from the same lot of wheat, since any deficiency in composition of the white flour is more than offset by the more thorough digestion. The investigations with cereals have also shown that the different cereal breakfast foods on the market differ little in real nutritive value, though they differ widely in cost and quite considerably in method of manufacture. As regards the amount of digestible nutrients furnished, they closely resemble the coarser breads. The different kinds of breads have been shown to be wholesome and economical foods, and the same may be said of the standard cereal breakfast foods. The use of different kinds of breads and other cereal foods is an easy way to secure variety in the diet—a consideration of very great importance.

In connection with the studies at the University of Tennessee it has been shown that dried legumes (peas, beans, and cowpeas) are quite thoroughly digestible and are economical sources of vegetable protein. The thoroughness of assimilation depends in considerable degree on the method of preparation, being in general greatest when the legumes are so thoroughly cooked that they are readily masticated and thoroughly mixed with the digestive juices in the stomach and intestinal tract.

As shown by the investigations at the University of Illinois, the losses which meat sustains when cooked in hot water are greater than when dry heat is used, as in roasting or baking, but in all cases the losses of nutrients are small. The constituents which influence flavor are the meat extractives rather than the insoluble portions of the flesh, and the development of flavor in cooking depends to a large extent upon methods which modify the character of the extractives. The application of dry heat in different ways develops flavor to a greater extent than cooking in hot water. The character of the cooking utensils used, the degree of heat applied, the length of time the cooking is continued, and other factors bearing on the question of flavor and palatability have been studied.

One of the most important of the recent deductions from the respiration calorimeter experiments carried on at Middletown, Conn., is the formulation of a set of factors for computing the carbon dioxid and energy output of man at rest and performing muscular work of different degrees of severity. With these factors it is possible to compute with reasonable accuracy the energy expended per day by a man engaged in any one of the ordinary occupations or trades, and so to form an approximate estimate of his actual food requirements. The results of the respiration calorimeter experiments, combined with those of dietary studies and digestion experiments, make it possible to compute with great accuracy the body requirements for protein and energy, and a large amount of data has been accumulated which will be used in a revision of the tentative dietary standards.

The digestion experiments carried on in connection with the respiration calorimeter work and with other branches of the nutrition investigations have resulted in standard factors for computing the digestibility of different classes of nutrients with reasonable accu-

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racy. The respiration calorimeter experiments have also furnished standard factors regarding the diurnal output of carbon dioxid and energy, the relative amounts excreted by day and by night, the normal variations in body temperature, the relation between excretory products and food consumption, and similar topics, and have furnished valuable data regarding problems of ventilation and hygiene.

NUTRITION INVESTIGATIONS FOR 1905–6.

During the coming fiscal year it is proposed to continue the studies of the nutritive and economic value of fruits and nuts; the effects of methods of cooking meat of known origin on palatability, flavor, and true nutritive value; dietary studies in public institutions and in tropical regions; studies of the digestibility and nutritive value of different foods, especially corn meal ground and prepared for the table in different ways, corn flour and other corn products, and of wheat flour prepared in other ways than as bread; and studies of the relative consumption and assimilation of different ash constituents of food with a view to formulating dietary standards for mineral matters.

In the experiments with the respiration calorimeter it is proposed to make additional studies of the effects of muscular work and mental work on the income and outgo of matter and energy, the relative amounts of work performed by men and women engaged in some of the more common occupations (a question on which no accurate information is at present available), and studies of the efficiency of the body as a machine.

It is also proposed to study the protective power of different kinds of clothing and other topics related to body hygiene.

The new lines of work proposed are to include an extended series of studies of the digestibility and true nutritive value of cheese of different degrees of ripeness manufactured under controlled conditions. In connection with this work, studies will be made with the respiration calorimeter to secure data on the relative expenditure of energy by the body in digesting cheese and other foods and the ease and rapidity of digestion of cheese of different degrees of ripeness. This work will be carried on in cooperation with the Bureau of Animal Industry.

Studies will also be undertaken of the digestibility and relative nutritive value of rice and rice products prepared for the table in different ways.

Plans have also been made for some special investigations regarding the protein requirements of the body, as such data are needed in connection with the accurate data furnished by the respiration calorimeter experiments regarding energy requirements in the formation of exact dietary standards.

With our present resources supplemented by the generous help of the cooperating institutions, it will be possible to continue the work already under way, and as certain phases of the investigation are completed from time to time, to make at least a beginning along some of the new lines. It is not possible, however, to in any way adequately meet the demands for information (necessarily dependent upon investigations) made by teachers in schools, universities, and medical colleges, instructors in domestic science, students, institution managers,

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and those interested in settlement work and other philanthropic enterprises, nor the demands made by the general public for miscellaneous information regarding nutrition and summaries of data already available.

The pedagogics of nutrition should receive attention, and it is a matter of great importance to formulate the available facts in such a way that the subject may be more satisfactorily taught than at present. Such a plan necessitates closer cooperation with teachers and investigators interested in home economics, physiology, and hygiene and related branches.

It is very important that the Department, interested as it is in agricultural education, should make a closer study of the courses of instruction in home economics or domestic science as taught in schools and colleges, especially the colleges of agriculture and mechanic arts, throughout the country with a view to aiding teachers in their work to a greater degree than at present. Satisfactory text-books on food and nutrition (important branches of home economics) are not available, and at present a large proportion of the teachers depend on Department publications to supply their place. There is a demand for more nutrition publications, both technical and popular, like those now issued, and also for new series on somewhat different lines. Thus, simple leaflets are needed for instruction in primary grades, and charts showing in graphic form results of nutrition investigations are very often requested, as well as directions for preparing specimens and other material illustrating the composition of food in a concrete way, as was done by the Office at the St. Louis Exposition. It is also very important to gather together and place in pedagogical form the widely scattered facts relating to food values, food economy, storage and transportation, the principles which underlie cookery, proper food combinations, body requirements, digestibility and hygiene of food and living, and related questions. In the teaching of animal production, agronomy, and other agricultural topics, pedagogical work similar to that proposed has resulted in the formulation of very satisfactory courses of instruction.

While much information regarding the results of nutrition investigations has been already disseminated, there is need of a more effective system for convincing people of the practical benefits to be derived from the systematic application of these results in the home. A plan has therefore been prepared for undertaking demonstration work on dietary subjects in a way which experience gained in other lines has shown to be satisfactory. It is proposed to send competent instructors to different regions of the country to give short courses and demonstrations in nutrition and the hygiene of living, basing their teaching on the large amount of data available as a result of the nutrition investigations. For this demonstration work it would be best, doubtless, to select localities which have manifested most interest in the problem and which may be effective centers for the dissemination of information to large numbers of people. A preliminary study of the situation has made it evident that the demand already exists for work of this nature.

It is proposed that the Department demonstrators shall meet the teachers, mothers, and home makers in a given locality and bring to their attention the most important facts regarding relative food values; suitable food combinations; dietary standards and ways of

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securing a rational and well-balanced diet; economy in the purchase of food and in the use of articles of home production; sanitation and hygiene as related to the care, storage, handling, and marketing of food; the preservation of any surplus food supply; the principles which underlie cookery, and something of the digestibility and utilization of food by the body, and the factors which influence the functions concerned in body nutrition. The basis of such teaching will necessarily be the Department technical and popular bulletins reporting and summarizing the results of the nutrition investigations. Series of specimens illustrating graphically the nutritive value of foods, their digestibility, the relative losses sustained in different methods of cooking, etc., could also be provided, as well as charts and photographs. In so far as possible it is proposed to work in connection with teachers' institutes, farmers' institutes, clubs for home study, and similar organizations; and if the work is undertaken it is hoped that the home makers may be encouraged to continue it on their own account after the course of instruction is completed.

Success has attended some of the demonstration work which the Department of Agriculture has undertaken in other lines, and there is every reason to believe that demonstration work in nutrition would be equally successful. The nutrition investigations as at present carried on are well organized along the lines which must be the foundation of teaching and demonstration under any circumstances, and in the future the special requirements of this teaching work should be borne in mind in making plans for investigations.

Some attention has already been given to making plans for presenting the results of the nutrition investigations in the way outlined, and it is believed that by the means proposed it is possible to bring the important facts of nutrition more directly to the home makers than in any other way. A moderate outlay for work of this kind will, it is believed, make the publications of the Department on human nutrition far more effective aids toward the improvement of the diet of our people.

The proper and economical feeding of our families and groups is a subject the importance of which can hardly be overestimated. A knowledge of the most important facts of food and nutrition can not fail to produce an improved diet. At the same time there is every reason to believe that the saving of both money and energy in the family would be very large. It is each year becoming more possible to apply to home management the same system of control of conditions which has been so successfully applied to farm management and to business enterprises.

To provide for some extension of the work of this Office relating to human nutrition, particularly by increasing studies of dietaries suitable for public institutions, and demonstrating the ways in which the results of nutrition investigations may be practically applied in the household and utilized in courses of instruction for girls and women in public and private schools and colleges, I have recommended an increase of $5,000 in the appropriation for nutrition investigations.

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Irrigation and Drainage Investigations.

The Irrigation and Drainage Investigations, which form a division of the work of this Office, have been directed as hitherto by Dr. Elwood Mead. They include investigations of all phases of rural engineering carried on by the Department, except those by the Office of Public Roads. During the past year field investigations in irrigation and drainage were carried on in 32 different States and Territories, while the investigations of the applications of power as applied to farm work and the design and construction of farm buildings have embraced questions of importance to the entire country.

IRRIGATION INVESTIGATIONS.

INVESTIGATIONS IN THE WESTERN STATES.

The following is a brief outline of the field work in irrigation carried on in the different States during the past year:

California.—The work in California is in charge of Prof. S. Fortier. This work is cooperative, the State having appropriated $15,000 to help defray expenses for the fiscal years 1906 and 1907. It is also carried on in cooperation with the State Agricultural Experiment Station at Berkeley, which has furnished office room and the facilities of the mechanical laboratory for making tests of pumps.

In southern California the water supply is limited, and the economical use of water is the paramount problem of irrigation. The returns from irrigation are so great in this section that every improvement in irrigation practice which lessens losses and extends the area which a given quantity of water will serve is of momentous importance.

The studies of losses by seepage and evaporation from both water and soil surfaces have been continued at Pomona and Riverside, in southern California, and in the San Joaquin and Sacramento valleys, in northern California. Experiments are being made to determine how far it is possible to hold moisture in the soil by means of cultivation. It is believed that when these are completed they will replace conjecture with definite data for the guidance of the practical irrigator.

Prof. R. H. Loughridge is assisting in the soil-moisture studies and Prof. Herbert Nowell is dealing with the influence of water and soil temperatures on the rate of evaporation from water and soil surfaces.

In northern California there are many irrigated districts where water is abundant, at least during the greater part of the year. Here a knowledge of the most economical methods of using water is not so important as to know how much water can be profitably applied; that is, how far copious irrigation can be made to add to the yield of crops without injuring the soil. Experiments to determine these questions are being carried on at Tulare and Chico under field conditions and by the use of tanks filled with soil where the quantity of water given off by plants and evaporated from soil surface is accurately determined by frequent weighing of the tanks.

Studies of the relative advantages of different methods of preparing land for distributing water over it, begun last year in the

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Modesto and Turlock districts under Mr. Frank Adams, have been continued, and measurements of the duty of water under ordinary practice have also been made.

The tests of the efficiency of pumping plants used to lift water for irrigation have been continued by Prof. J. N. Le Conte, with Mr. C. E. Tait and Mr. R. S. Daniels as assistants. The practical importance of these investigations is recognized not only by irrigators and the makers of pumping machinery in this country, but by irrigation authorities of other countries. The field tests to determine the amount of water lifted by different pumps and the cost of irrigation where water is pumped will be supplemented during the coming winter by laboratory tests to determine the efficiency of different types.

NEVADA.—In Nevada the measurements of the duty of water have been continued and have been supplemented by studies to determine the movements of soil and seepage waters. This information will aid in planning drains for swamped areas. The work in Nevada is cooperative, part of the expenses being paid from a special State appropriation of $2,000. Prof. Gordon H. True, of the Agricultural Experiment Station at Reno, is the field agent in charge. He has been assisted during the past year by Mr. A. E. Wright.

UTAH.—The irrigation investigations in Utah have included measurements of the duty of water under ordinary field practice, experiments to determine the water requirements of crops ordinarily grown in Utah, the best methods of applying water in irrigation, the best stages at which to irrigate different crops, the influence of scanty or copious irrigation on the yield and quality of crops, especial attention being paid to the influence of irrigation on the size and sugar content of sugar beets, and the relation of different quantities of water used in irrigation to the accumulation of alkali in the surface soil. These studies show that much can be done in preventing alkali from injuring crops by the adoption of right methods of irrigation. In several sections of the West lands which had been declared worthless because of the high percentage of alkali in the soil are being made to yield bountifully under irrigation with certain methods of applying water, whereas with other methods the crops are a failure. Some methods tend to accumulate alkali on the surface; others to drive it down into the subsoil and to carry it away in seepage water.

These investigations are being made in cooperation with the State experiment station, the State having made a special appropriation of $10,000 for aiding in this work. The work at the Utah Experiment Station is under the direction of the irrigation engineer of that station, Prof. W. W. McLaughlin, and the field work is being carried on by Mr. E. R. Morgan, of this Office.

ARIZONA, NEW MEXICO, COLORADO, AND WYOMING.—The irrigation investigations and experiments carried on in Arizona, New Mexico, Colorado, and Wyoming are in charge of Mr. F. C. Herrmann, with headquarters at Cheyenne, Wyo. They include measurements of the duty of water in Arizona, New Mexico, and Colorado; cooperative experiments with the sugar-beet growers and sugar manufacturers of Colorado to determine how sugar beets should be irrigated and cultivated to secure the best results, the object being to determine

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whether or not by skillful irrigation the sugar content can be increased without diminishing the yield. The experiments in the irrigation of sugar beets include tests of the effects of different quantities of water and of different methods of cultivation to conserve the soil moisture. Mr. F. W. Roeding is conducting these experiments.

At Cheyenne an experimental farm has been established to study the best methods of cultivating land to conserve soil moisture, the effects of winter irrigation, and the cost of irrigating small tracts by pumping. The Cheyenne experiments have grown out of the relation between dry farming and irrigation in the reclamation of the semiarid region, and the purpose is to determine how 5 or 10 acres of irrigated land under intensive cultivation can be made to supplement the cultivation of larger areas of the vast region where rainfall is irregular in occurrence or limited in amount. The work at Cheyenne is being carried on under a cooperative arrangement, which includes the Office of Experiment Stations, the State Experiment Station of Wyoming, and the Union Pacific, Burlington, and Colorado and Southern railways.

TEXAS.—The significant feature of irrigation in Texas is the large number of small individual irrigation works. There are large pumping plants in the rice districts and a few costly canals elsewhere, but the greater part of the reclaimed area is watered by small individual works. The irrigators are nearly all beginners. They need instruction about how to prepare land for irrigation and how to spread water over fields. To meet this situation, Mr. Harvey Culbertson, an expert in pumping and irrigation, has given the past two years entirely to meeting farmers, singly and collectively, and giving them advice about the methods of preparing land and applying water, at the same time gathering data regarding the irrigation conditions and possibilities of Texas, especially in the direction of irrigation by pumping and through the construction of small storage reservoirs. The numerous letters from irrigators, telling of the money they have been saved, leave no doubt as to the benefit of this course of preliminary advice and information.

NEBRASKA.—The irrigation investigations in Nebraska are in charge of Prof. O. V. P. Stout, of the Nebraska Agricultural Experiment Station. They are cooperative, a special appropriation of $5,000 having been made by the State legislature to pay part of the expenses for the fiscal years 1906 and 1907. They include experiments in Chase County, to determine how irrigation by pumping may be extended to aid in settling the lands now devoted to grazing. These experiments are similar to those being carried on at Cheyenne, Wyo., and are intended to develop a system of agriculture which will combine irrigation and dry farming in the reclamation of the semiarid parts of the country. Measurements of the duty of water in the irrigated sections are also being made.

OREGON.—The irrigation investigations in Oregon are in charge of Mr. A. P. Stover. They include the gathering of data regarding the cost of preparing land for irrigation and the expense of irrigating under different methods of applying water, and measurements of the duty of water under different canals where there is an ample water supply for all seasons. In central and eastern Oregon there are

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valleys where water is abundant in winter and spring, but a supply for the entire season can not be had. This has led to a considerable and profitable development of winter irrigation. In sections having 10 to 15 inches of rain all the staple farm crops are being grown from the moisture stored in the soil and subsoil by winter irrigation. The aid of the Department has been given to improving and extending the methods of building ditches and preparing land for this kind of irrigation.

WASHINGTON.—In Washington Prof. O. L. Waller, of the State Agricultural College, has continued his measurements of the duty of water in the Yakima Valley, and of the rise and fall of soil water in the irrigated areas. Both of these are factors which bear on the accumulation of alkali in the surface soil, which is one of the live irrigation questions of this section. The records of the rise and fall of soil water are being kept, as this is the surest guide to the size of drain tile necessary to hold the soil water down to a definite level.

MONTANA.—In Montana there are large areas of very fertile land, now used for pasturage purposes, which there is reason to believe can be put to better use. In much of this country water for the irrigation of small areas can be had by building small reservoirs or by pumping from underground supplies. Winter irrigation, which is being so successfully practiced in Oregon, ought to be equally effective here. There are many parts of the State where underground water can be had with lifts of from 10 to 30 feet, and many places where reservoirs holding water enough to irrigate 10 to 50 acres can be built. The success of this kind of irrigation will depend on a high duty of water being secured. The land must be prepared, the water distributed, and the surface cultivated in such a way as to reduce the losses from evaporation to a minimum. The tools and methods needed to secure a high duty of water in irrigation will, so far as they relate to plowing and cultivation, be effective in promoting the growth of crops in regions of scanty rainfall. In both cases the object to be secured is the retention of moisture. In part because the small irrigated tract will probably be combined with the larger unirrigated farm, one being the complement of the other, and in part because the union of nonirrigated tracts with the irrigated gives a better opportunity to test tools and machines, these experiments in evaporation and conservation of moisture have included unirrigated areas.

The experiments in Montana are cooperative, the cooperating parties being this Office, the Montana State Experiment Station, and the Northern Pacific Railway. Prof. W. W. McLaughlin is directing this work in Montana, which is being carried on in four localities. These results will be supplemented by the collection of data as to the cost of pumping water for irrigation at a number of other points in the State.

PUMPING WATER FOR RICE IRRIGATION.

In the rice irrigation districts of Louisiana and Texas the pumping of water for irrigation constitutes about one-fourth of the cost of a crop. Measurements are being made of the duty of water and of evaporation losses from fields. These will show how much water has to be pumped. Tests of many pumping plants have been made and records secured of the cost of pumping water. These tests show

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great diversity in the types of machinery used and in the results obtained from a given amount of fuel, the efficiency of pumps and engines combined in the tests reported varying from 50 to 80 per cent. This work is in charge of Prof. W. B. Gregory, who has charge also of cooperative investigations of the pumping of water for rice irrigation in Arkansas.

IRRIGATION IN THE EASTERN STATES.

Irrigation is becoming a more and more important factor in intensive agriculture throughout the Eastern States. Market gardeners are employing it as they do fertilizers, as a means of increasing yields and insuring crops against the vicissitudes of rainfall. An examination of 189 irrigated areas in Maryland, Pennsylvania, New Jersey, New York, Massachusetts, and Rhode Island was made this year. This irrigation falls in two classes—meadows and truck gardens. The irrigation of meadows is usually by gravity from springs or brooks. The water for truck gardens is pumped, the cost in some cases reaching as high as $60 an acre-foot.

SPECIAL INVESTIGATION OF THE IRRIGATION AND DRAINAGE OF CRANBERRY MARSHES.

The growing of cranberries in Wisconsin and New Jersey is an important industry and one which is highly profitable under favorable conditions. Drainage and irrigation are both features of this industry. In Wisconsin, in cooperation with the State experiment station, experiments are being made to determine the best methods of drainage and the extent to which drainage can be utilized to protect against injury from frost. In irrigation, studies are being made to determine the cheapest method of constructing storage works and the size and character of the ditches needed to flood fields with sufficient promptness. Prof. A. R. Whitson, of the Wisconsin State Experiment Station, has charge of the field work in Wisconsin, and Prof. E. B. Voorhees, director of the New Jersey State Experiment Station, of the work in New Jersey.

IRRIGATION INSTITUTIONS.

At the request of the Department of Justice, Dr. Elwood Mead was detailed, last November, to assist in protecting the interests of the Government in the litigation over the water rights of the Arkansas River, this being an interstate case of great importance to which the Government is a party. This litigation will go far to determine the rights of irrigators in different States to the water of interstate streams, and will largely influence irrigation development in the future.

The three years' investigation of the water-right questions of the Platte River has been completed and the report has been published. This investigation has involved the collection of data showing the amount of water appropriated in the different States from this stream, the character and amount of the return seepage water, and the limitations on rights to water recognized in the different States, and the manner in which these rights are enforced and protected. The information gathered on this stream has a value outside of its immediate application to Platte River because it is a fairly representative concrete illustration of the questions created by the diversion and use of interstate streams in irrigation.

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DRAINAGE INVESTIGATIONS.

The field work in drainage is under the direction of Mr. C. G. Elliott, and during the past year has included studies and collection of data on many important questions pertaining to the betterment of the overwatered areas in both the arid and humid portions of the country, and also the consideration and giving of expert advice on a few large projects requiring the united action of many landowners under the provision of State laws. The following is an outline of the most important work undertaken or completed during the year:

The studies of the drainage problems of the Kankakee marshes in Indiana, begun in 1904 under the direction of Prof. W. D. Pence, of Purdue University, have been continued. This marsh and the surrounding areas requiring drainage embrace an area of about 300,000 acres. Local district organizations have undertaken the drainage of portions of this area, but the success of their undertakings is in a measure connected with prompt carrying away of excess of flood waters from the entire tract. The task undertaken by this Office is to gather together the results of all that has been done, which includes studies of the operation of drains in the smaller areas, and to make additional supplemental studies needed to prepare plans for the complete reclamation of this immense tract, or to determine how far this is feasible. M. H. Downey, drainage engineer, has been assisting Professor Pence in the conduct of these investigations during the present season.

The excessive rainfall of the present season has served to demonstrate the necessity for comprehensive drainage of the valley of Red River, in North Dakota. The need for this has been realized for many years, but to secure the best results it is necessary that a comprehensive plan be prepared. The work is of such magnitude that the farmers interested have delayed beginning it until they could have a reliable estimate of its cost. This Office was requested to aid in the preparing of these plans and estimates, and this resulted in a cooperative arrangement between this Office, the various counties of the Red River Valley, North Dakota, and A. L. Fellows, State engineer of North Dakota, for the making of studies and gathering of needed data. The State Agricultural College of North Dakota was actively interested in the arrangement for this work, and a number of the students of this college have been engaged in its prosecution during the summer. Mr. John T. Stewart, of this Office, is in charge.

The Delta lands of Mississippi and Louisiana are of exceeding fertility, but their productive value has been greatly impaired by lack of drainage. The carrying out of this improvement has been delayed by the failure of a number of attempts. The value of underdrainage, both in lessening the cost of cultivation and increasing yields, is fully recognized, and this Office has been asked to take charge of investigations to determine the special features of drainage needed to overcome the difficulties heretofore encountered. An investigation has been made and plans prepared for the drainage of a tract in the Yazoo Delta, under an agreement with the landowners by which an experimental tract is to be drained at their expense.

The sugar and rice lands of the Mississippi Delta in Louisiana all have to be drained, and to the ordinary problems of drainage there

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is added here the necessity in many instances of providing artificial drainage by pumping the water. In some instances all of the drainage water must be lifted over levees needed to protect fields from overflow. At present in this region open ditches are almost universally employed, this being due to fears that tile underdrains will not succeed. There are three factors which menace the success of underdrains—the fine silt of this valley, the difficulty in providing a prompt outlet to the water which fills the underdrains when rainfall or overflows overtax the capacity of pumping stations, and the low grades which underdrains must of necessity have. The investigations of the Office embrace, therefore, machinery for digging drains, the pumping problems involved in the prompt removal of the water which fills drains, and the methods to be employed in preventing underdrains filling with silt. These investigations are being carried on by Mr. J. O. Wright.

The studies of the ditching, levee, and pumping problems involved in the reclamation of the overflowed lands along the Illinois River, made and reported upon last year, are being supplemented by additional observations of this region during the present season.

Experiments in the effects of drainage are being carried on in Iowa in cooperation with the State experiment station.

RECLAMATION BY DRAINAGE OF LANDS INJURED BY ALKALI AND SEEPAGE WATER.

In irrigated districts, drainage is the most effective means of removing the injury caused by surplus and seepage waters, accompanied as this usually is by the accumulation of alkali in the surface soil. The most effective means of reclaiming these areas is by properly constructed surface or underdrains so located as either to intercept the seepage water or secure its prompt removal and the permanent lowering of the water plane to a considerable depth below the surface. The work of preparing plans for such underdrains was begun by this Office in 1902, among the first of these being those in the Yakima Valley in Washington.[a] These have worked successfully and added many thousands of dollars to the value of the lands and to the crop production of the areas dealt with.

In response to urgent requests from individuals and district organizations in the Yakima Valley in Washington, contemplating the construction of extensive drainage works, Mr. Elliott visited that region during the past summer and gave expert advice regarding drainage plans for the removal of seepage water and alkali from about 10,000 acres, and the Office has promised to continue this work and the preparation of plans for a much larger area.

In addition to the above work, expert advice has been given to drainage districts in Iowa, North Dakota, and Nebraska. Taken together, the plans prepared or modified by the experts of this Office involve the drainage of more than a million acres of land, while the experimental work undertaken has a vital relation to the improvement of several million dollars' worth of property.

One of the most extensive cooperative drainage investigations now being carried on by the Department is in Utah, where in cooperation with the State experiment station and with the farmers of different

[a] See U. S. Dept. Agr., Office of Experiment Stations Bul. 147.

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localities, tile and other drains will be laid to determine the best system of drainage for reclaiming lands rendered unproductive through the accumulation of seepage water and alkali. The experiments made in Utah last season to determine the benefits of underdrainage in the swamped lands of Cache Valley have proven a complete success. The productiveness of this land during the present season has been so greatly increased that the Office has been requested to prepare plans for a large extension of this drained area and this is now being done. Drainage in this section promises to more than double the productiveness of the land. Every acre drained will practically add as much productive wealth to the State as the addition of an acre to the irrigated area. The reclamation of the swamp areas in Utah is one of the most important of the State's agricultural problems. It promises not only to add to the available water supply but also to reclaim and to return to production a large area of the best land in the State.

The plans prepared two years ago for the drainage of the lands near Fresno, Cal., have not yet been carried out, the people of the district not having been able to agree as to methods. Recently it has been proposed to carry out a portion of this plan, and the Office has been solicited to give advice regarding the modifications needed to permit of this. Requests have also been made to make a comprehensive investigation of the drainage problems of the Imperial Valley in southern California, and this will be begun during the coming winter.

In no section of the United States is drainage destined to play a more important part in increasing the value and productiveness of land than along the Atlantic seaboard and the Gulf coast. During the past summer Mr. W. E. Herring has been making a study of the drainage problems of the rice lands of Georgia and the Carolinas. For many years the rice planters have had to contend not only with changing labor conditions, but with higher water in the streams in spring and lower water in summer, due to cutting off the timber and cultivating the uplands. The purpose of these studies was to ascertain whether it is feasible to completely drain the rice lands and thus make them capable of growing all kinds of farm and garden products.

For several years the Office has been carrying on experiments to test the value of tile underdrains to prevent the erosion of hillsides on the headwaters of the tidal rivers of Georgia and the Carolinas. These hillsides are largely devoted to the cultivation of cotton, which requires clean culture, and thus leaves the soil in a condition to be rapidly eroded by winter rains. Terracing has been largely resorted to to prevent this, but in some instances this has not proved effective, and experiments are being made with tile underdrains to supplement and protect the terraces. The results of these experiments, while not conclusive, have been encouraging. Fields where terraces could not be maintained before the underdrains were put in have stood for two years without a single break. The methods and tools for constructing terraces and the methods of protecting terraces are an important subject for the farmers of the South, and must in the near future receive greater attention from the owners and cultivators of hill lands throughout the eastern half of the United States. The melancholy spectacle of hillsides washed and gullied by rains and abandoned to weeds and briers is altogether too frequent. Unless the destructive methods of cultivation which have

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resulted in this are checked, it will before many years materially affect the agricultural wealth of a large part of our country. No feature of rural engineering is of more importance to the whole country than the introduction of methods for protecting hillsides from erosion.

Between New Orleans and Brownsville, Tex., on the Gulf coast, there is a stretch of land varying from 50 to 100 miles wide, nearly all of which will be improved by drainage, and much of which must be drained before it can be cultivated at a profit.

THE COLLECTION OF GENERAL INFORMATION ON IRRIGATION AND DRAINAGE.

Through the personal investigations of the members of this division working in the field and through the cooperative arrangements with the different State experiment stations, information of much value regarding irrigation practice and the economic results of irrigation is being collected. During the past season the data gathered in sections where the duty of water is being determined has included figures showing the cost of water to irrigators, and statistics of the yield and the value of crops grown by irrigation. A bulletin summarizing the methods of constructing small storage reservoirs, the value of these reservoirs, the cost of maintaining them, and the experience of farmers who have built them as to the important questions of maintenance and utilization, will soon be published.

Information is being gathered as to the effectiveness of ditching machinery and the kinds of machinery needed for different features of drainage work.

OTHER BRANCHES OF RURAL ENGINEERING.

The experiments and investigations of pumping, where employed to provide a water supply in irrigation or to remove water in drainage, have shown how important it is that farmers should know how to care for and operate this machinery. The fact that for a given amount of fuel some of the pumps tested did seventeen times as much work as others, shows the waste and loss which lack of mechanical knowledge can cause.

What is true of pumping is true of all kinds of farm implements and machinery. Every year the tools which the farmer uses become more complicated and require more knowledge and skill to keep them in proper condition and to use them in the most effective manner. The revolution wrought in the work of the farmer by the introduction of different forms of power to take the place of man or animals is illustrated by the change from the flail to the steam thrasher and from the slow-moving ox team to the traction engine and the automobile. This change is world-wide, but it is nowhere as great as in the United States. Because of this there is especial need of educating the farmer in a knowledge of mechanical principles. This fact is beginning to be recognized and increased attention is being given to this matter by the agricultural colleges, the State experiment stations, and this Department.

For several years this Office has done a considerable amount of work in connection with applications of power to farm work, in order to

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answer the numerous inquiries received by the Department and referred to this Office for attention. Since the irrigation and drainage investigations became a division of the Office, some investigations of the application of power in irrigation were inaugurated and some valuable results obtained. During the present year, under the authority granted by Congress, this work has been systematized through the appointment, as an agent and expert, of Prof. C. J. Zintheo, formerly professor of farm mechanics in the Iowa State College. In this way it is hoped that the many important questions connected with farm machinery and the use of power on the farm can be much more effectively studied.

The broad question which needs investigation is: What forces outside of animal power can the farmer most effectively utilize in carrying on his work? One of the cheapest is wind, and outside of horsepower no motive power has been so generally used on the farm as the windmill, but its present uses are altogether insignificant when compared to its possibilities under the recent discoveries of science. The improvements in electrical storage batteries make it seem possible that the farmer may in the future light his house by electricity generated by windmills, and that stored electrical currents may be utilized to turn motors to perform many of the heaviest labors of the household as well as the barnyard. Thus far the chief use of the windmill has been to pump water. This is an intermittent and temporary service. Mills designed for this are of extreme lightness in order to save expense in material and transportation. From the standpoint of the more important and continuous service which the windmill may perform, this type of construction has serious defects. The Office is now carrying on experiments, in cooperation with the agricultural experiment station of Iowa and at the irrigation investigation station at Cheyenne, to determine the efficiency of mills of different types for power purposes and in order to determine what modifications should be made in mills built for pumping to make them most effective when built for power uses. Manufacturers of this class of machinery are showing deep interest in these experiments, and we are assured of their active cooperation.

The use of engines in plowing land, pumping water, thrashing grain, grinding food, and operating the machinery of dairies is making the improvement in types of gasoline, crude oil, and steam engines of greater and greater practical importance to the farmer. The ability to utilize this kind of machinery is changing the plan of supplying country homes with water. Instead of tanks built above ground, water is stored below and lifted by air pressure to any desired height.

Denatured alcohol has especial practical interest to western farmers as a source of power for farm machinery. Alcohol can be manufactured from many waste farm products, such as small or unsalable potatoes, the waste of beet-sugar factories, and cornstalks. In order to use alcohol for this purpose, it must be freed from the internal-revenue tax, and to make this possible it must be rendered unfit for a beverage. This can be done by adding some repugnant substance, such as benzine or wood alcohol. Alcohol so treated has been exempted from taxation in most European countries, and it is there manufactured from agricultural products at a sufficiently low

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cost to compete with gasoline. There is some reluctance to taking this step in the United States, because no substance for denaturing has as yet been found which can not be separated from it cheaply by distillation. This difficulty is encountered in other countries, the Russian Government having offered a prize of $5,000 for the discovery of such a substance. Alcohol can be used in the ordinary gasoline engine with some small changes in the vaporizer, made necessary by the fact that alcohol is less inflammable. In the monthly Consular Trade Reports for July, 1905, Mr. Frank H. Mason, consul-general at Berlin, states that "the manufacture and industrial uses of alcohol were never so great, so important, and so varied as now." This increased use in Germany has raised the price so that it can not compete with gasoline for important uses, like the running of automobiles, but with the tax removed it could be manufactured in this country from the waste products of the farm at less than half the present German selling price. Arrangements are being made for the conduct by this Office of experiments to determine the exact industrial value of this form of power. There is special need of this information, because the matter is likely to be a subject of legislation in the United States in the near future.

IMPROVEMENTS IN THE DESIGN AND CONSTRUCTION OF FARMHOUSES AND FARM STRUCTURES.

In 1903 the committee on rural engineering of the Association of American Agricultural Colleges and Experiment Stations made a report recommending that there be included in the work of the Department of Agriculture investigations in the designing and construction of farmhouses and farm buildings to secure efficiency and economy in their use and to contribute to the healthfulness and attractiveness of farm life. The following reasons were given for this recommendation:

> In the construction of farm buildings, both barns and houses, the farmer is almost entirely dependent on his own knowledge and ingenuity in preparing plans and often in their execution. The designing of city buildings is largely in the hands of architects and engineers, and they are constructed by expert mechanics. They have, therefore, a finish and convenience which add largely to the attractiveness of city life. In the country, however, exactly the reverse is true. The great majority of farm buildings are unsatisfactory, whether considered from the standpoint of appearance, durability, adaptability to the work to be done, healthfulness, or pleasantness for the occupants. Some problems in connection with farm buildings need careful study. Among these is ventilation. The fact is we do not know either the effect of poor ventilation or the most efficient means of securing good ventilation. But the majority of the improvements to be wrought do not require research so much as the application of skill and ingenuity in design. One illustration of this is the fact that nothing is of more service in a home than a convenient water system. Much of the dislike which many women have to farm life comes, consciously or unconsciously, from the heavy work of handling water in cooking and washing, all of which could be easily saved by the adoption of readily available means. There is no reason why a farmhouse should not be as attractive as a city house, and there is no reason why the grounds surrounding farmhouses should not be made as attractive as city parks. It is largely because farm life and the farm home are not attractive that many of the enterprising, aggressive youth of the country flock to the cities.

The remarkable change which is taking place in the kind of material entering into farm structures emphasizes the wisdom of this recommendation. Reinforced cement and concrete are largely dis-

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placing wood and stone in all engineering structures, and would do so increasingly in those of the farm if farmers only understood their manipulation and possibilities.

During the last year this Office has, in connection with its irrigation and drainage investigations, found it necessary to determine the cost and value of reinforced concrete and cement to be used in flumes and siphons in canals, water pipes for conduits for conveying water, and to take the place of tile in drains. It will add little to the expense and immensely increase the value of these investigations to include investigations of the various forms of artificial stone as material for the more permanent structures on the farm, including cement walls, cement foundations, stable floors, silos, water tanks, fence posts, etc. Much information on these subjects has been gathered through cooperative investigations by this Office and the State experiment stations of Wisconsin and Iowa. This will be included in a bulletin soon to be issued. In addition to the practical benefits to be derived from original investigation, there is need in the Department of an expert in this branch of rural engineering to answer the numerous inquiries sent in by farmers about the betterment of sanitary conditions or about improvements wrought by the changes in farming methods. The Department can, by answering these inquiries and the preparation and publishing of bulletins which will be available for the use of agricultural colleges and high schools, awaken influences which will have an enduring effect on the convenience, usefulness, and attractiveness of our rural homes. What is needed is a sufficient appropriation to pay the salary of one expert, and traveling and incidental expenses. Five thousand dollars for this purpose has been included in the estimate.

COOPERATION WITH AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS IN RURAL ENGINEERING.

One of the functions of this Office is to aid the agricultural college in bringing each line of its work to the highest efficiency, both in teaching and research. The more progressive institutions have recognized the importance of rural engineering as a factor in country life and have added courses in this subject to their curricula, but as the work is new and very few men are prepared for it there has been a great demand that this Office should take charge of certain investigations and outline courses of study. The data upon farm machinery and farm building construction are very meager, and in order to put these subjects clearly and specifically before the students, the colleges are looking to this Office for aid in the direction of investigations and in the collation of information suitable for class work.

Farm-machinery investigations have for years been conducted by the agricultural institutions of Germany, France, Belgium, Sweden, Norway, Denmark, and Russia, greatly to the benefit of the farmers of those countries. The experiments already made by the farm mechanics section of the Iowa State College and the University of Illinois have demonstrated that implement manufacturers of this country are more than anxious to cooperate in such experiments, which are of benefit alike to farmers and manufacturers. Such investigations deal only with types of machines and principles of con-

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struction and are not intended to advertise any individual firm or make of machine.

The scope of the work done by the Irrigation and Drainage Investigations makes its title misleading. A more suitable designation of this work would be "Rural Engineering," and a change to this designation is urgently recommended.

During the past year the members of this force have been crowded into illy ventilated and widely separated rooms. The work has therefore been carried on under conditions of great inconvenience and personal discomfort. The accumulation of maps, plans, and samples of certain structural designs and results of experimental tests, as well as the need of facilities for carrying on in Washington certain lines of experimental work, makes it indispensable that additional quarters be provided. This can not be done in the buildings owned by the Department, and provision should be made for the rental of rooms and the purchase of certain essential equipment. The outlay will not be great, but the appropriation act for the next fiscal year should authorize this.

Although the increase in the appropriation made by the last Congress made possible a considerable extension of the work, this has not enabled us to keep pace with the needs of States and communities for advice and information. Important works for the reclamation and improvement of agricultural districts are being delayed until the advice of this Office upon the same can be had. The necessity for more extensive work is especially urgent in the following lines: The giving of advice regarding methods to be used in providing a water supply for small tracts in the semiarid region, the making of drainage investigations for the relief of overwatered areas in both the humid and the irrigated sections of the country, investigations to show the methods and tools to be used in the development of irrigation as a factor in dry-land farming in the semiarid sections, and the collection of information to guide farmers in the selection and use of pumping and other farm machinery.

There is a steadily growing interest in this work throughout the country and pressing demand for its further expansion. The rapidly increasing demands of a growing population make it imperative that every agricultural resource of this country shall be used with the highest degree of economy. In the arid region water is the most valuable agricultural asset. It is only by introducing proper methods in its use that investments in irrigation works, whether by the Government or by private individuals and companies, can be made profitable or the full irrigable area brought under cultivation. In the humid region the demand for an expansion in agricultural production requires the solution of drainage problems and the reclamation of the many millions of acres of swamp lands which this will bring about. The studies in rural engineering needed to devise methods of protecting the hillside farm from erosion concerns not only our present agricultural wealth but the preservation of important areas of this country for the needs of future generations. It is evident, therefore, that the studies which are being made by the Irrigation and Drainage Investigations are an important factor relating to the expansion of American agriculture and the welfare of millions of people who are dependent, directly or indirectly, upon agriculture for their subsist-

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ence. To make adequate provision for the necessary growth of this work I recommend that the appropriation for the next fiscal year be $100,000, of which $1,200 shall be available for rental of quarters.

PUBLICATIONS ON IRRIGATION AND DRAINAGE.

During the year ended June 30, 1905, the following publications relating to irrigation and drainage investigations were issued:

Irrigation in Northern Italy, Part I, by Elwood Mead, Chief of Irrigation Investigations. (Bulletin No. 144, pp. 100, pls. 17, figs. 14.)

Preparing Land for Irrigation and Methods of Applying Water. (Bulletin No. 145, pp. 84, pls. 7, figs. 33.)

Current Wheels: Their use in Lifting Water for Irrigation. (Bulletin No. 146, pp. 38, pls. 4, figs. 21.)

Report on Drainage Investigations in 1903, by C. G. Elliott, Drainage Expert, Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 147, pp. 62, pls. 5, figs. 12.)

Report on Irrigation Investigations in Humid Sections of the United States in 1903, under the direction of Elwood Mead. (Bulletin No. 148, pp. 45, pls. 3.)

The contents of Bulletins Nos. 144–148 were fully noted in the report of the Director of the Office for 1904.

Progress Report of Cooperative Irrigation Investigations in California, by S. Fortier, Irrigation Engineer, in charge of Pacific district. (Circular No. 59, pp. 23.)

This circular gives the terms of the agreement under which cooperative investigations of this Office and the State board of examiners are carried on in California, and summarizes the work there along the following lines: "(1) Description of plants in use, (2) field tests of pumping plants in operation, (3) laboratory tests of typical pumps, and (4) duty and value of water under pumping plants." Data are given for tests and practical trials, including cost of operation of different pumping plants, evaporation as influenced by temperature and season, and a comparison of methods of applying water.

The Work of the Office of Experiment Stations in Irrigation and Drainage. (Circular No. 63, pp. 31.)

A reprint from House of Representatives Document No. 381, Fifty-eighth Congress, third session, of the testimony of the Director of the Office and the chief of Irrigation and Drainage Investigations before the Committee on Irrigation of Arid Lands of the House of Representatives.

Irrigation and Drainage Investigations of the Office of Experiment Stations, by R. P. Teele. (Document No. 723, pp. 23, pls. 2, figs. 5.)

A pamphlet prepared for distribution at the Louisiana Purchase Exposition.

The following were prepared and submitted for publication but not actually printed before the end of the fiscal year:

Water Rights on Interstate Streams. (Bulletin No. 157, pp. 118.)

Annual Report of Irrigation and Drainage Investigations, 1904. (Bulletin No. 158, pp. 755.)

A report of investigations carried on under the direction of Elwood Mead, chief of Irrigation and Drainage Investigations, including Review of the Work of the Year, by R. P. Teele; Irrigation in Santa Clara Valley, California, by S. Fortier; The Distribution and Use of Water in Modesto and Turlock Irrigation Districts,

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California, by Frank Adams; Relation of Irrigation to Yield, Size, Quality, and Commercial Suitability of Fruits, by E. J. Wickson; Irrigation Conditions in Imperial Valley, California, by J. E. Roadhouse; Mechanical Tests of Pumping Plants used for Irrigation, by J. N. Le Conte; Irrigation in Klamath County, Oregon, by F. L. Kent; Irrigation Investigations in Yakima Valley, Washington, 1904, by O. L. Waller; Irrigation Conditions in Raft River Water District, Idaho, in 1904, by W. F. Bartlett; Irrigation Investigations at New Mexico Experiment Station, Mesilla Park, for the Season of 1904, by J. J. Vernon; Irrigation Investigations in Western Texas, by Harvey Culbertson; Pumping Plants in Texas, by C. E. Tait; Irrigation in Southern Texas, by A. J. Bowie; Rice Irrigation in Louisiana and Texas in 1903 and 1904, by W. B. Gregory; Rice Irrigation on the Prairie Land of Arkansas, by C. E. Tait; Irrigation Experiments at Fort Hays, Kansas, 1903 and 1904, by J. G. Haney; Irrigation near Garden City, Kansas, 1904, by A. B. Collins and A. E. Wright; Pumping Plants in Colorado, Nebraska, and Kansas, by O. V. P. Stout; Irrigation near Rockyford, Colorado, 1904, by A. E. Wright; The Irrigation and Drainage of Cranberry Marshes in Wisconsin, by A. R. Whitson, and Report of Drainage Investigations, by C. G. Elliott.

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REPORT OF THE CHEMIST.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., July 1, 1905.

SIR: I have the honor to transmit herewith the annual report of the work done in the Bureau of Chemistry during the fiscal year ended June 30, 1905, accompanied by a description of the work proposed for the present year.

Respectfully, H. W. WILEY, *Chief.*

Hon. JAMES WILSON, *Secretary.*

WORK OF THE YEAR, WITH RECOMMENDATIONS.

The investigations conducted by the Bureau of Chemistry during the fiscal year ended June 30, 1905, were largely along the same lines as are described in the report for the fiscal year ended June 30, 1904. The work of the Bureau continues to be of a widely diverse nature. The problems of a chemical nature which are regularly connected with the art of agriculture naturally receive first attention. These problems relate to the composition of fertilizers, the nutritive value of food, its adulteration, and the study of the technical processes dependent upon agriculture. The nature of these problems does not change from year to year, but their aspects are continually varying. New lines of investigation are opened up and new conditions are established. These variations in the aspect of the problems require a constant readjustment of the methods of investigation and the character of research best suited to solve the questions which are presented.

Of the technical problems of a chemical nature which have received special attention during the past year may be mentioned the industries relating to leather and paper making. The demands for leather with the increasing population and changes in the conditions of life make a corresponding demand upon those great industries which, in addition to furnishing the raw material of which the leather is composed, must supply the materials with which it is prepared for use. The tanning problem, therefore, assumes greater and greater importance, and special studies, as will be outlined farther on, have been made of tanning materials.

The character of the imported tanning materials has also received consideration. It is evident that in the near future the agricultural industries of the world must supply increasing quantities of tanning

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materials, and these quantities can not be derived from the sources now available. The sources of the raw material must be increased and the tanning industry, instead of being simply dependent upon the stores which nature has provided in the forests and other places, must become an actual constructive industry, extending by artificial means the cultivation of plants which produce tannin and improving the technical applications which condition its use.

The source and supply of materials for paper making are also becoming a problem of great agricultural importance. The utilization of our forests for the manufacture of wood pulp has in the past few decades furnished an apparently inexhaustible supply of cheap and valuable material. It is true that paper made from wood pulp does not have the properties of paper made from linen or silk, and for certain characters of paper can not take the place of these materials, but for the ordinary purposes for which paper is used—such as the publication of newspapers and magazines, wrapping paper, etc.—the material made from wood pulp or straw pulp has proved reasonably satisfactory.

It is now realized, however, that the supply of wood pulp is not inexhaustible, and the utilization of other forms of cellulose for this purpose becomes almost a necessity. The investigations of this Bureau look not only to the supply and character of the product from these pulps, but also to their correct chemical treatment to secure their most economical application. In connection with these investigations an important investigation has been taken up relating to the quality of paper employed for the permanent records of the Government. Realizing that the cheaper papers made from wood pulp and other cheap materials have not the lasting qualities which are desirable in paper intended for permanent records, an investigation has been inaugurated of some of the older records of the Government for the purpose of comparing the composition of the paper on which they are printed with that which is at the present time used for similar purposes. The conclusion seems to be justified that at least some copies of every public document should be printed upon paper of superior lasting quality in order to preserve in a permanent shape—that is, as permanently as the best paper or parchment can secure—the records of governmental activity.

Directly connected with this problem, also, is the continued investigation of inks for printing purposes in connection with such written and printed documents. It is evident that an ink should be not only useful at the time of the publication of the writing, but, if intended for a permanent purpose, should not fade, oxidize, or disappear with advancing years.

The investigation by the Bureau during the year just ended into the character of drugs and chemicals has been of great practical as well as scientific interest.

One of the unfortunate circumstances connected with the almost universal use of drugs is found in the fact that the physician as a rule is not consulted in such matters. Representations of the virtues of remedies are made in such a way as to catch the eye, captivate the imagination, and lead to their use. There are thus placed within the reach of every citizen almost numberless drugs or remedies which are in a form to be purchased or used without the intervention of

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the skilled physician and solely upon the whim or taste of the consumer. The most regrettable feature in connection with this condition of affairs is the fact that many of these remedies contain drugs which are of a character to induce a permanent and unfortunate habit of consumption. The danger which attends the use of drugs such as morphia, cocaine, chloral, chloroform, etc., is well known. Not less seductive is the presence of alcohol in remedies of this character. The result is that, even without the knowledge of the patient, an appetite for these drugs is established which may afterwards prove unconquerable. It is evident that drugs of this kind should be sold only under the strictest supervision of the State. Many of them are recognized as poisonous, and others when sold under their own names are subject to excise restrictions, both on the part of the General Government and of the States. It is therefore a loss of revenue on the part of the Government and a constant menace to the consumer to permit such drugs to be sold under fanciful names which do not reveal their character or quality and which lead the consumer to form the drug habit without at first any knowledge of the character of the drug consumed.

Investigations by this Bureau along this line during the past year have been very fruitful and extremely helpful to the Post-Office Department, which has appealed to this Bureau constantly for assistance in controlling the evils above referred to. Quite as important also in this respect have been the results of the examinations to secure purity of the drugs and chemicals employed in the Bureau for scientific purposes. The details of these investigations will follow.

The collaboration of this Bureau with other Departments of the Government has continued and increased during the past year. The beneficial results of having some central laboratory to which problems of various kinds connected with the general conduct of the affairs of the Government can be referred are becoming more and more evident. The establishment of special laboratories for the consideration of particular cases throughout all the Departments would entail vast expense and would institute a service which would be devoid of that unity of purpose and that directness of execution which attend a central laboratory.

The various problems which have been considered for the different Departments of the Government will appear in the proper place in this report. This work should be fostered and extended, not because of its special relation to agriculture—although many of the problems are of an agricultural nature—but because of the benefit which these investigations confer upon the Government at large.

The supervisory work which this Bureau exercised, at the request of the Secretary of the Treasury, over the polarization of the sugars at the various ports was terminated by the action of the Secretary of the Treasury December 31, 1904. This supervisory work had continued over a period of many years, and the results of the supervision were of the most favorable character. Before its institution the differences between the polarizations of the sugars at the various ports of entry were very pronounced, and at times approximated as much as 1 per cent. During the years in which this supervision was specifically exercised the agreement between the polarizations of the various ports became very close, rarely exceeding an average of one-tenth of 1 per cent per month, and often falling within that limit. The work above

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referred to was transferred, at the request of the Secretary of the Treasury, to the Bureau of Commerce and Labor.

During the year the investigations of the Department respecting the growth, manufacture, and preservation of table sirups were continued at Waycross, Ga. A very elaborate investigation was also made under the same authority in regard to the purity of maple sugars and sirups manufactured in various parts of the United States. In connection with the manufacture and utilization of table sirups many intricate problems arise which can be answered only by an appeal to first sources. To this end, therefore, samples of the pure products were secured upon the certification of their manufacturers and subjected to a careful study in order that, if possible, some standard of purity might be reached.

Investigations by the Bureau of Chemistry respecting the effect of the different yeasts of pure cultures upon the chemical composition of cider have been continued with most gratifying results. It is evident, of course, that the flavor and general character of a beverage of this kind must depend upon its composition. In just what way, however, chemistry would associate the composition with the character of the product has not been entirely worked out. The object of the investigations has been not only to determine the value of pure-culture yeasts of different sources in producing a cider of value, but also to determine by the careful control of the fermentation and analyses of the raw and finished products the changes which have taken place in the composition of the article during the process. The enzymes secreted by the yeasts which produce the fermentation act as chemical reagents and the process of converting a fresh apple juice into a finished cider is a series of chemical reactions. These we have endeavored to trace in the work of the Bureau and to associate therewith the actual chemical composition of the cider and its food and condimental value. This is the character of a work which has been undertaken by chemists in other parts of the world, and one which should be extended to other food and condimental products.

An extensive investigation of the composition of cereals has been undertaken in connection with the Bureau of Plant Industry and has formed a very prominent part of the work of one section of the Laboratory of Plant Analysis during the past year. Important relations which exist between milling properties, nutritive value, and physical characteristics are disclosed in these investigations. Connected with these investigations are those specifically authorized by Congress in the study of American barleys in relation to their brewing qualities. Important progress has been made in this line of investigation, but it is necessarily one which requires a considerable time for its completion.

The investigation on the effect of environment upon the composition of the sugar beet, which has continued for a period of five years, has been concluded during the past year, and a detailed statement and a summary of the work prepared for publication. The results of this investigation show the relative importance of the various factors of environment in the production of a beet rich in sugar.

The collaborative work in connection with the Bureau of Animal Industry respecting the composition and character of renovated butter has been continued, and other studies of the chemical composition of dairy products have been conducted.

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Important collaborative work has also been undertaken by the Bureau in connection with the Bureau of Plant Industry in the study of the quantity of hydrocyanic acid occurring in various species of cassava grown in Alabama and Florida. These data show a wonderful variation in the quantity of hydrocyanic acid present and lead to the belief that it is not a constant constituent, but that it is evolved and disappears in a somewhat continuous way during certain periods of the development of the plant.

The work in collaboration with the Bureau of Entomology in the study of insecticides has been continued, and in the same laboratory important investigations have been concluded respecting the composition of the mineral waters offered upon the markets in the United States for the general use of the consumer and for medicinal purposes.

The work of the Bureau in collaboration with the Association of Official Agricultural Chemists has been continued as usual. The officials and referees of this association have been made special correspondents of this Bureau in order to more certainly establish the organic relations which exist between the Department and this association, and which have been recognized by Congress in making this association the official adviser of the Secretary. The food standards committee of this association has held two meetings under the auspices of the Secretary of Agriculture to discuss the important problems relating to the standards of purity of food products. The first meeting was held in Washington in December, 1904, and the second in Chicago in May, 1905. At the former meeting the previous discussions which had been held before the committee were considered, together with the data submitted therewith, and additional standards were recommended for adoption and were promulgated by the Secretary.

At the meeting in Chicago the time was chiefly devoted to the hearings of the trade and experts on the proposed standards for edible oils, fruit products, and flavoring extracts.

During the year the experiments on the effect of preservatives, coloring matters, and other substances added to foods upon health and digestion have been continued. During the year formaldehyde and copper sulphate were subjected to a critical study, and additional investigations were made with salicylic, sulphurous, and benzoic acids. The data of these experiments are being prepared for publication as rapidly as their magnitude permits.

The inspection of imported food products has been considerably extended during the year. An additional laboratory was established in San Francisco, and the preliminary steps were taken for the establishment of laboratories at Boston, Philadelphia, New Orleans, and Chicago. Important modifications of the methods have been adopted with a view to facilitating the inspection, in order to avoid delay and to secure more speedy determination of the questions which are presented for solution. While there has been in some quarters considerable opposition to the execution of the law, it is satisfactory to know that the great majority of the importers as well as practically the whole body of consumers of our country heartily support the efforts of this Department to secure a high standard of purity and freedom from adulteration and injurious substances in imported food products.

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Exporters from other countries have perhaps justly complained in some instances that the foods which they send to this country are subjected to more careful inspection than foods of a similar character manufactured in the United States. These statements are made as a rule by those who are not acquainted with our peculiar system of government and do not realize that the Congress of the United States has no authority to establish police regulations for the various States. The complaints of those in foreign countries who send food products to this country, however, would be modified and perhaps eliminated if Congress should establish a rigid inspection of food products entering into interstate commerce in this country, an inspection which practically would be the same as that required for imported food products. Were this accomplished, the inspection by this Department of imported food products and those offered for interstate commerce, supplemented by the thorough inspection on the part of the State authorities of food products manufactured and sold within the States, would secure for our people immunity from most of the frauds in food products to which they have been so long subjected.

While there are many things connected with the inspection of food products imported from foreign countries which might be improved, and which experience has shown to be inefficient, upon the whole the law has been effectual and no one has seen fit to deny its authority or restrict it by appealing to the courts. In the execution of the law an effort has been made to place upon the importer no undue restriction, to free him from every possible annoyance, and to facilitate in every possible way the speedy determination of all questions connected with the inspection.

The inspection of food products of American origin intended for export to foreign countries has not reached the magnitude which its value would warrant. Our exporters seem to prefer taking their chances with the regulations of the countries to which they send their products rather than to assure themselves before shipment that the products exported are satisfactory for entry into those countries. In a great many instances, therefore, during the past year exporters have appealed to our State Department for redress when the products which they have offered have been refused. This is a condition of affairs in which this Department is powerless to offer any aid to our exporters, since the law specifically requires that any inspection made by this Department shall be previous to exportation. It is believed that, as our exporters become better acquainted with the efficiency and purpose of the act authorizing the inspection of foods intended for export, they will, in greater numbers, avail themselves of the opportunity of securing from this Department a statement respecting the character of every exported food which may be submitted to the officials of the country to which the foods are sent.

The growth of the Bureau is such as to render necessary the securing of additional quarters, at least temporarily, pending the completion of the buildings now in progress, and steps have been taken looking to this end.

The clerical service of the Bureau has done efficient work during the year, but, owing to the peculiar difficulties of work of this kind in a chemical bureau, it has not always been possible to keep the work up to date. The correspondence of the Bureau constantly increases,

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and, under present regulations, all requests addressed to the Bureau must receive not only consideration, but respectful answer. Very many of these requests seem to have no connection with the work of the Bureau, and yet they must receive attention.

In the preparation and compilation of the work of the Bureau for publication, special difficulties are encountered of a character which have made it desirable to secure clerical service in which a knowledge of chemistry is associated with the other qualifications necessary in this service. There has therefore been established by the Civil Service Commission a grade of chemical clerk, and during the year a number of persons have been appointed to service in this Bureau under certification of this kind.

In the work of the Bureau it is evident that a great part of the energy expended should be employed in the study of new problems, in the making of investigations. At the same time the Bureau endeavors to keep first in view the practical side of its work and to shape it so that it may prove of advantage to the American farmer and the American consumer.

DIVISION OF FOODS.

The study of the composition of fruit with special reference to the changes of composition during ripening and the different methods of storage has been continued in collaboration with the Bureau of Plant Industry. Samples of six varieties of peaches were taken at different stages of their growth and the composition was determined. In general, the plan of study and methods of examination were the same as those previously employed in the study of the ripening of apples. The results of this work are embodied in a bulletin which is now in press. A preliminary study was also made of the ripening of oranges and persimmons.

In connection with the study of the ripening of fruit considerable attention has been given to the composition of pectin bodies, and the results obtained serve to shed some light on the study of the so-called "ether-free extract" or carbohydrate bodies of agricultural products.

The materials precipitated by alcohol from second-pressing cider and from apple must were also studied and compared with each other and with the pecto-cellulose of the apple. The substance precipitated by alcohol from apple must is found to be very similar to that precipitated by alcohol from second-pressing cider, and both differ widely from the insoluble solids of the apple. It thus appears that the organisms present in the fermenting pomace have a very similar effect on the insoluble apple solids to that exercised by the natural forces of the fruit cell.

The Division of Foods has studied the chemical changes occurring during the manufacture of cider vinegar on a commercial scale. This study has been necessitated by the varying opinions of those interested in the subject regarding the composition of normal cider vinegar. A representative of the Division visited several large vinegar manufactories and obtained samples of the fresh apple musts, and also of vinegar made from them in different stages of its manufacture, first, in ordinary barrels, and, second, in a small generator patterned after the generators employed in the economical manufacture of vinegar.

In cooperation with the Drug Laboratory of this Bureau and in

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collaboration with the Bureau of Fish and Fisheries of the Department of Commerce and Labor, the Division of Foods has undertaken a comprehensive study of the composition of cod-liver oil. The thirty-five samples of oil used in this study were prepared by the Bureau of Fish and Fisheries from fish obtained in several localities. Some of the results of this study were embodied in a paper on "Color tests of cod-liver oil," read before the meeting of the American Chemical Society and published in the journal of that society.

The Division has given considerable attention to the occurrence in nature of the chemical substances ordinarily used as food preservatives and to the various theories that have been advanced to explain the alleged presence of such preservatives in foods prepared without their addition. A number of common fruits were examined for the ordinary preservatives, with the result that, with the exception of benzoic acid in cranberries, no preservative was found in the natural fruit in sufficient quantity to lead to analytical error. The claim which has been recently advanced, however, that as much benzoic acid occurs naturally in the cranberry as is ordinarily added to other fruits for their preservation was found by this Division to be true. Samples of cranberries were, therefore, secured at various stages of maturity and the formation of benzoic acid was studied. This formation was found to begin with the appearance of color on the berry. It then increased somewhat slowly until the color was well advanced, after which it increased very rapidly until the picking time of the berry.

A study was also undertaken of the influence of the process of canning upon the content of chemical preservatives in canned goods and upon the reliability of the methods ordinarily used for detecting preservatives in foods. For this purpose several varieties of foods were prepared and canned by the ordinary commercial method after the addition of varying amounts of preservatives, and in some cases without the addition of any preservative. No reaction for preservatives was found in any case where preservatives were not added to the food before canning. In such cases the results of all experiments were clear and decisive. No reaction was obtained which should in any way confuse the experienced analyst. The examination of the food canned with varying amounts of preservatives has not been completed. In the case of formaldehyde, however, it was found that that preservative was largely destroyed by the process of canning.

During the last fiscal year, as heretofore, the Division of Foods has done an important work in studying and comparing analytical methods for the examination of foods. This work has been in connection with the Association of Official Agricultural Chemists, in which the chief of the Division of Foods is at present referee on food adulteration. It has also been influenced to some extent by the requirements of the regular work of the Division. As referee on food adulteration of the Association of Official Agricultural Chemists the chief of the Division of Foods has worked in collaboration with nineteen prominent food chemists in the United States and Canada; and in addition to this he and his collaborators, each in his special field, have had the collaboration of a much larger body of food chemists.

Among the contributions of the Division of Foods to this subject during the fiscal year may be mentioned the collaborative work on the Dalican titer test; on the cold test for oils; on the Belfield test for

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the detection of beef stearin in lard, which were reported at the last meeting of the Association of Official Agricultural Chemists and published in the Proceedings of that meeting.

In addition to the preservative work mentioned above, considerable collaborative work was done with chemists of other food laboratories in the study of the methods ordinarily employed for detecting preservatives in foods. The results of this work were reported to the Association of Official Agricultural Chemists.

The study of methods for identifying and determining the relative amounts of nitrogenous compounds in meat extracts and other foods was continued and the results reported to the Association of Official Agricultural Chemists.

During the first three months of the fiscal year the entire time of the chief of the Division and that of two of his assistants was taken up with the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition. This exhibit consisted of a working laboratory, illustrating the work of the Bureau of Chemistry.

A largely increased amount of time and attention has been devoted to the laboratory work relating to the enforcement of the law regarding imported foods. The manner of conducting this work has been changed during the last fiscal year by the establishment of laboratories at the ports of New York and San Francisco.

At the beginning of the last fiscal year arrangements were made by which the foods imported at the port of San Francisco were examined at the laboratory of the State University of California. This was continued until January, 1905, when the San Francisco laboratory was organized. Considerable time was occupied in equipping the laboratory before work could be begun, and with the exception of the last month the chief of the San Francisco laboratory was entirely without assistance of any kind.

The organization of these port laboratories has resulted in a largely increased efficiency in the enforcement of the imported food law. A much more complete inspection is possible than under the previous organization, and the work is so expedited as to remove the hardship that was previously felt by importers. Usually the chemical examinations necessary to determine whether a given shipment of foods is in conformity with the law are somewhat superficial, being confined to two or three tests on each sample. In a great many cases, however, a much more complete examination is necessary.

Statement of imported food samples received by the Bureau of Chemistry and results of inspection reported from July 1, 1904, to July 1, 1905.

Result of inspection.	Wine.	Meat.	Olive oil.	Miscellaneous.	Total.
Found contrary to law:					
Released without prejudice to future decisions in similar cases	78	5	2	186	271
Admitted after the labels were changed to harmonize with the law	9	2	.....	173	184
Required to be reshipped beyond the jurisdiction of the United States or destroyed	9	3	9	12	33
Condemned but not disposed of	1	.....	.....	.....	1
Total	97	10	11	371	489
Found to comply with the law	321	46	146	694	1,207
Total number of samples examined from invoices detained	418	56	157	1,065	1,696
Samples taken from invoices not detained	400	.....	1	331	732

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In addition to the examinations made for the purpose of deciding whether or not shipments represented by the samples examined can be imported into the United States in conformity with the law of March 3, 1903, a complete examination has been made of 400 samples of wine, and the examination of about 650 samples of whisky and brandy is now under way.

As in previous years, a considerable amount of the time and energy of the employees in the Division of Foods was occupied with the investigation of the influence of preservatives on nutrition.

During the last fiscal year, in addition to the investigation of methods and other comparative studies for which materials in the laboratory were used and special samples were not required, the Division of Foods examined 3,750 samples of imported foods, 2,579 samples relating to the hygienic table, and 1,009 miscellaneous samples, making a total of 7,338 samples.

DIVISION OF TESTS.

During the year about 250 samples have been received and tested. Of these, 127 were rocks intended for road building; 30 were clays intended for the manufacture of brick, tile, pottery, etc.; 24 were asphalts; 3 were Portland cement; 8 were paving brick; 1 was wood paving blocks, and the rest miscellaneous and for identification.

In addition to the work necessary to make reports on these samples a variety of research investigations has been carried on. The investigation of the action of water upon rock powders from the special standpoint of the study of the cementing value of road materials has been carried on, and the results of this investigation have already been presented for publication as Bulletin No. 92 of the Bureau of Chemistry.

The investigation upon the manufacture of reinforced concrete fence posts has been made, and a larger number of posts have been molded with different forms and shapes of reinforcement and tested in the Olsen testing machine.

An investigation has been begun and is well under way in which the effort is being made to discover why modern steel wire sold to the farmers for fencing purposes corrodes and rusts so much more rapidly than the older wires that were in the market some twenty to thirty years ago. Some progress has been made, and it is hoped that practical benefit will accrue as a result of the investigation.

A number of investigations have been made on the subject of the physical properties of road materials with a view of seeing to what extent it will be possible to improve the binding power by artificial means.

Important investigations have been carried on to see what effect the admixture of clay in sand-cement concrete has on the strength of the material. A new and large impact testing machine has been designed and is now in process of construction by the Division. When completed this machine will be the largest impact testing machine—so far as we know—in existence in any laboratory. With our smaller impact testing machine a long series of investigations has been carried on in conjunction with Mr. Clifford Richardson, as special agent, to investigate the value of impact testing on asphalt street mixtures for city pavements. In the course of this investigation a very large number of

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test pieces have been broken—several hundred, in fact—which are not included in the samples mentioned.

There is every reason to believe that this impact test is going to be of the greatest assistance to engineers in charge of laying city pavements by enabling them to make mixtures particularly adapted to different kinds of traffic.

With the beginning of the present fiscal year this Division was transferred in its entirety to the Office of Public Roads.

PLANT ANALYSIS LABORATORY.

During the past year considerable time has been devoted to checking, editing, and arranging the manuscript which embodies the very extensive soil studies that have been conducted in the previous organizations of this laboratory since 1895.

This laboratory has devoted most of the time during the past year to collaborative work with the Bureau of Plant Industry, this being the chief purpose of its creation. The work of a plant specialist, supplemented by that of a chemist, leads to a rational development that could not be attained by either in independent research. During the past year two bulletins, in collaboration with the Bureau of Plant Industry, have been completed and submitted for publication.

The chemical work on hemp developed some particularly interesting features. While the hemp plant is considered a heavy feeder on the principal plant foods, the amount removed per acre by the fiber, the only marketable product, is about 1 pound of phosphoric acid, 2 pounds of potash, and 5 pounds of nitrogen in an average crop. The great bulk of the plant food necessary to make the crop has been leached out in the retting process generally employed. While this leaching is accomplished on the ground where the crop was grown, it takes place in winter, when the ground is frozen, and probably a great portion of the plant food is lost. It developed that the vat retting would preserve this possible waste to an extent sufficient to justify its cost, the waste products in many instances being valued at $20 per acre. Simultaneously the office of the Botanist developed the possibility that vat retting so improved the fiber and increased its market value that its cost was justified. There can be no better illustration of the value derived from collaboration in such work.

The addition of the economical discussion is a new feature in such bulletins and possesses much practical interest. To-day the producer must consider supply and demand.

The chemical work on cassava developed the fact before assumed, that the poisonous property of this plant varies with the environment. The same pedigreed varieties were grown in two States—Mississippi and Florida. Varieties which were deadly poison in Mississippi were harmless in Florida. This is of wide practical importance, inasmuch as cassava is utilized as food for animal and man. A second point developed was that the content of hydrocyanic acid is not of a stable character; that the same plant may be harmless at one time and later on become poisonous. Through this collaboration it has developed that poisonous varieties of cassava can not be identified through botanical means.

There has for a long time existed the belief that cassava exists in distinct classes, poisonous and nonpoisonous. There has been some

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skepticism regarding this belief, and not until this collaboration was under way did the question become definitely settled that the poisonous nature of a variety could not be foreseen through its botanical characteristics.

This work has shown that the content of starch bears no definite relation to the content of hydrocyanic acid. The practical importance of these points is better realized when they are coupled with the large amount of work the Department is doing to introduce, improve, and acclimate this plant in the Gulf States.

A study of the tobacco plant was inaugurated at the beginning of the year and is now well under way. One variety—White Burley—has been collected so far in thirty-six distinct tobacco districts in Kentucky, this being the home of the White Burley, and the source of approximately 40 per cent of all the tobacco grown in the United States. Each sample represents the space of 20 feet of a selected row.

From this fair approximations of yield in leaf and stalk have been computed. These samples are being analyzed with a view to estimating the loss of plant food through improper uses of the stalk and stems, which are discarded and not returned to the soil, excepting in a very few instances where the stripping is done by large houses.

The value of this product can be realized when it is stated that in some of the heavy yields in the best Kentucky districts this work has shown that the phosphoric acid, potash, and nitrogen removed in the stalk and leaves, computed on the basis of the market quotations, are worth many dollars per acre. This work is one of a series of studies designed to illustrate the feeding nature and the influences which cause variations in the composition of the general farm products of this country.

CEREAL SECTION.

The work carried on in this section is in accordance with cooperative arrangements between the Bureaus of Chemistry and Plant Industry, dating from November, 1904. From that time to July 1, 1905, there have been analyzed 32 samples of wheat, in duplicates, for water, ash, fat, fiber, albuminoid nitrogen, pentosans, reducing sugars, sucrose, gluten, and phosphoric acid in ash. One hundred and thirty samples of barley and malt have been received, in which 101 determinations of total sulphur, 101 of total phosphorus, 112 of lecithin phosphorus, and 36 of phosphorus in ash have been made. Besides the above, 178 extra albuminoid nitrogen separations have been carried out, making a total of over 800 determinations of all kinds.

The results obtained by using different precipitants for the separation of albuminoid nitrogen (and hence amido bodies) show that Stutzer's method now used needs some modification. This determination is most important in arriving at a correct valuation of foods and feeding stuffs. A little more work (now going on) is needed before coming to any final conclusion.

The amounts of sulphur and phosphoric acid in barley vary from 0.127 to 0.255 per cent and from 0.71 to 1.09 per cent, respectively, these great variations indicating that the organic bodies from which the sulphur and phosphorus are derived may play an important rôle in brewing. Complete analyses of barleys and of the malts and beers made from them ought to give most valuable data.

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Similar results are obtained in the lecithin-phosphoric acid determination, the per cent varying from 0.46 to 0.83. This variation also indicates that this substance may be of importance not only in brewing, but in nutrition.

The comparative determinations of total phosphoric acid and phosphoric acid in ash show that only a trace, if any, of phosphoric acid escapes on ashing in a muffle such substances as wheat, barley, and malt.

PHYSIOLOGICAL WORK.—The work for the past year has been along the following lines:

(1) The continuation of the work of the preceding year on the composition and properties of durum wheat. The object of this work was the determination of the composition of durum wheat and flour in comparison with standard varieties of wheat already grown in this country, and the testing of durum wheat flour as to its bread-making qualities. The work consisted of the analysis of numerous samples of durum wheat and flour, both the imported grain and that grown in the United States, and of three standard varieties of domestic wheat, viz, northwestern spring wheat, Kansas hard winter wheat, and soft winter wheat. In addition to this a large baking of both durum wheat patent flour and northwestern spring wheat patent flour was made through the cooperation of a local bakery, and the resulting bread was tested and analyzed. The results of this work are set forth in Bulletin No. 70 of the Bureau of Plant Industry, "The commercial status of durum wheat," by Mr. Mark Alfred Carleton and Mr. Joseph S. Chamberlain.

(2) The inauguration and the present continuation of work on the analysis and study of the relative feeding and commercial value of a large number of introduced varieties of oats and a special study of one particular variety, "Swedish Select," as to its particular merits, and the effect of change of environment, due to importation, on its composition and properties. This work has occupied the larger part of the year and is still going on.

(3) Research work. In connection with the first work spoken of, certain lines of abstract research have been followed out as time has permitted. The work has embraced two related problems: (*a*) Determination of "gluten" in wheat flour and a study of its composition and properties; (*b*) a study of the proteids of wheat and their relation to wheat gluten. In this connection, the chief of the cereal section has been, during the past year as during the preceding one, associate referee on the separation of vegetable proteids for the Association of the Official Agricultural Chemists.

The lines of work thus far mentioned were inaugurated and carried on through the suggestion and advice of Mr. Mark Alfred Carleton, cerealist in charge of cereal investigations of the Bureau of Plant Industry.

INSECTICIDE AND AGRICULTURAL WATER LABORATORY.

During the last year the Insecticide and Agricultural Water Laboratory has examined 625 samples. Some of these analyses were made as part of the work in special investigations of the laboratory, which will be published later, and part were done for other labora-

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tories of this Bureau and other divisions and bureaus of this and other Departments of the National Government. The work may be summarized as follows:

Of irrigation waters 41 samples were examined, 39 for the Office of Irrigation and Drainage Investigations and 2 for farmers; of sanitary water analyses 45 were made, namely, 5 for the Bureau of Forestry, 5 for the War Department, 12 miscellaneous samples, and 23 for a special investigation on American mineral waters, the results of which will be published in due time; of mineral waters 29 were examined, 23 for a special investigation and 6 for miscellaneous parties.

Of insecticides 51 samples were examined, 11 for the Bureau of Entomology, 2 for the Bureau of Plant Industry, 4 for farmers, and 34 samples for a special investigation (the results of which will be published) on the composition of samples of formaldehyde sold on the American market.

Eighteen toxological examinations were made, all for the Bureau of Entomology.

Four samples of disinfectants were examined, 3 for the U. S. Census Bureau and 1 for the Panama Canal Commission.

Two complete analyses of samples of gases were made for the U. S. Bureau of Fisheries.

As regards cattle-food analyses, which have during the past two years been made in this laboratory, 242 samples were examined, 157 for a special investigation on the composition of cattle foods sold on the American market that will be published during the course of the next year; 62 samples for the jury of awards at the Louisiana Purchase Exposition, 15 samples of grasses for the Bureau of Plant Industry, and 8 samples for miscellaneous parties.

A more or less complete food analysis has been made upon 100 samples of malts and barleys, the results of which work are to be published in a bulletin. Food analyses were also made upon 33 samples of Indian corn for the Bureau of Plant Industry.

For the Food Laboratory of this Bureau 23 analyses have been made.

Besides the above a number of samples which do not fall under any of the above heads have been examined, and one member of the laboratory force, as referee on insecticides, fungicides, and disinfectants, of the Association of Official Agricultural Chemists, has devoted a considerable amount of time to the task of testing and unifying methods of analysis on these classes of goods.

The following articles not yet published have been prepared and are now ready for publication:

(1) A study of American Mineral Waters.

(2) A study of the Hydrogen Peroxid Method of Determining Formaldehyde.

(3) A New Method of Determining Potassium.

DRUG LABORATORY.

During the past year there were 465 samples of material examined in this laboratory. Of this number 335 were chemicals, 64 plant drugs, 61 proprietary medicinal agents, and 5 of a miscellaneous character.

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CHEMICAL REAGENTS.

The chemicals examined were those regularly employed in chemical analyses in the Bureau of Chemistry, delivered on contract and special purchases. The objects of these examinations are, first, to insure reliable chemicals for analytical work; second, to secure data from which standards of purity can be constructed, and, last, to place competitors on a uniform basis.

The qualities usually specified were the best grades of the several respective types. It has been necessary to reject a goodly portion of the chemicals delivered, but it is gratifying to say that the proportion is appreciably less than a year ago. It is a common custom to append a label indicating high-grade goods to packages containing chemicals of an inferior grade. For example, "Chemically pure" can be found attached to containers filled with calcium oxid that is little better than the ordinary quicklime used in building, and what adds to the confusion is the fact that some of the designations used to indicate quality have both a commercial and a scientific meaning.

The committee on the testing of chemical reagents of the Association of Official Agricultural Chemists, in its first report clearly sets forth the necessity for the work in hand. Chemicals bearing the names of some of the best manufacturers were shown to be totally unfit for analytical work. The committee is continuing its work, and hopes to present an extended report at the next annual meeting of the association.

The Drug Laboratory has in its possession the analytical data of over 700 chemicals, and a bulletin is now in preparation giving these results and setting forth the proposed standards for these chemicals.

PLANT DRUGS.

Plant drugs were examined, consisting of the powdered potent drugs placed on the market by several dealers in the United States, with a view of ascertaining to what extent the goods conformed to the representations on the packages, and how rapidly deterioration takes place under given conditions, and of making a careful study and comparison of the analytical methods in use. The first report on this line of work was presented at the twenty-first annual convention of the Association of Official Agricultural Chemists by the chief of the Drug Laboratory, as referee on medicinal plants and drugs, and consisted of a comparative study of the methods largely employed in determining the amount of morphine present in opium.

PROPRIETARY MEDICINAL AGENTS.

The proprietary medicinal agents were examined at the request of the Post-Office Department, the Treasury Department, Senator W. B. Heyburn, chairman of the Committee on Manufactures, and in cooperation with the American Medical Association.

The Post-Office Department asked for the investigation of certain alleged remedies which, through their advertising literature, were heralded as being capable of curing all the ills that human flesh is heir to. One "complexion lotion" consisted of a solution of corrosive sublimate mixed with tincture of benzoin and glycerin. This mixture, it was claimed, would turn black skins white. A complex-

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ion powder consisted of Rochelle salt, and a complexion tablet was composed of extract of nux vomica, reduced iron, calcium carbonate, and sugar. The indiscriminate distribution of these poisonous tablets without caution resulted in the death of a child. Lean people were to be made fat by taking a "predigested olive oil" that was not predigested, but simply an emulsion of the oil; and "kinks" were to be removed by ample applications of a mixture of cocoanut oil and crude petroleum flavored with oil of bergamot.

For the Treasury Department were determined the amount of alcohol in several samples and the degree of purity in a number of others.

Eleven samples were examined for the American Medical Association. Some of the results obtained on headache powders have been made public through the association's journal.

COD-LIVER OIL INVESTIGATIONS.

This investigation was undertaken at the suggestion of the chief of the Drug Laboratory for the purpose of making a comparative study of American and Norwegian cod-liver oil, chemically, medicinally, and commercially, including the method of preparation, with a view to ascertaining whether there is any good reason for the present discrimination against American oils by the medical profession, and, if so, what it is and how the same can be removed so as to place the products of our home industry on an equal footing with the foreign oils. This work is in cooperation with the Division of Foods of the Bureau of Chemistry, and with the U. S. Bureau of Fisheries.

The Bureau of Fisheries is collecting oils concerning which there can be no doubt as to genuineness, investigating methods of manufacture, and sending the samples to this Bureau. Some of the oils have been examined chemically as to purity and their respective color reactions.

DRUG LEGISLATION.

Numerous requests have come from legislative bodies to present laws regulating the adulteration of drugs and the proper labeling of the same, as a result of which it was considered expedient to collect into bulletin form all Federal and State laws bearing on this subject, so that these inquiries could be fully and completely answered in the shortest possible time. This work is now in preparation.

PLANT ANALYSIS.

The analysis of one plant was begun with a view to determining, if possible, the active agent or agents of a plant claimed to have great curative properties. The work will be completed during the early part of the fiscal year beginning July 1, 1905.

MISCELLANEOUS.

One sample of essence of Jamaica ginger that had caused the death of an adult was examined and was found to be made up with wood alcohol, which is now known to be highly poisonous. Samples of bay rum and toilet water were also examined for wood alcohol, but it was not found. A sample of buckwheat was examined because

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of certain physiological effects that it produced and was found to be mixed with stramonium seeds, which are highly poisonous. Of the remaining samples, one was a cigar which was supposed to have been "doctored" and the other was meal poisoned with corn-cockle.

LEATHER AND PAPER LABORATORY.

One of the first pieces of work undertaken in this laboratory was an investigation of the various processes of extracting tanning materials for analysis. All of the methods commonly used possess some objectionable feature either as to accuracy or as to the time required to complete the extraction. As a result of our work it has been possible to shorten considerably the time required to obtain an extract ready for analysis and also to reduce the inconveniences of the older methods. This investigation has been published in the Journal of the American Chemical Society.

Sicilian sumac is an important tanning material which is imported into this country. During the past year it has been very generally claimed that before shipment this material is largely adulterated with substances inferior in color and in tannin content. With the assistance of the Customs Division of the Treasury Department we have secured a large number of samples from original packages in order to determine the kind and quantity of adulterants used. This work is progressing rapidly and will be concluded as early as possible, as both the importers and the consumers are interested in the results.

American sumac, while as rich in tannin as the Sicilian, is more objectionable in color and consequently brings a lower price. We are endeavoring to overcome this objectionable feature and to so prepare the American sumac that it may approximate the Sicilian in quality.

Samples of sod oils and degras have been collected as museum specimens and for analysis. Examination of these will be taken up as soon as practicable.

A number of miscellaneous samples of tanning materials have been analyzed, several of which were for the Bureau of Forestry. The study of the extraction of tannin from various tanning materials, begun during the year, is not yet completed.

PAPER AND PULPS.

The laboratory has examined a number of samples of various papers for the Post-Office Department and from this work has revised the formula for the postal-card contracts, making it definite and more difficult to evade. Decided improvement in the postal cards is expected from this work. The chief of this laboratory has also served upon the committee appointed by the Postmaster-General to open the bids for envelopes for all the Executive Departments and has tested a large number of envelope papers in this work. An examination of manila papers for the purpose of securing data upon which to base future envelope contracts has also been begun.

Many papers deteriorate so rapidly that they are valueless for public records. Many of the Government publications have shown

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evidence of deterioration, and for the purpose of studying this problem as it applies to book papers we are now securing from the Government Printing Office samples of each invoice of book paper received, and from the several Departments copies of their older publications for careful examination in the laboratory. That the work may be more complete we have requested samples from public libraries and from paper makers, and have also asked for an expression of opinion as to the chief causes of deterioration and methods for its prevention. This line of work will be extended to include all other classes of paper.

Examination of new raw material for paper making has been delayed for lack of space in which to erect digestion and other apparatus. This difficulty will soon be overcome, when the work will be pushed vigorously.

TURPENTINE AND ROSIN.

Turpentine derived from wood, either through destructive distillation or by steam distillation, while possessing many, if not all, the essential characteristics of turpentine distilled from the gum, differs in some particulars from gum turpentine; and, notwithstanding the fact that the price of gum turpentine is higher and the output is likely to be scarcer as the years go by, wood turpentine has not yet found a stable and satisfactory market. We are now engaged in working out the many chemical problems connected with the production of so-called wood turpentine. Its composition and adaptability to various industrial pursuits are also being determined.

We have arranged to secure through the Bureau of Forestry samples of crude turpentine at three different periods of flow, that we may determine with accuracy the constant of turpentine as a basis for the work on turpentine adulteration, outlined in the last report of the Chemist.

MISCELLANEOUS WORK.

In addition to the regular lines of work, the laboratory has made analyses of soils and fertilizers used in the sirup and sugar-beet work, as well as of miscellaneous samples of these materials which have reached us from various sources. This laboratory also participated in the work of the Association of Official Agricultural Chemists on fertilizers and on tannins. A large share of the time of the chief of the laboratory has been devoted to correspondence which has been referred to us from the different bureaus and offices of the Department, not only on tanning leather, turpentine, destructive distillation of wood and paper, but also on fertilizers, their composition and proper use.

To this laboratory has been assigned a part of the work on whisky now in progress in this Bureau. This occupies about a third of one man's time. Much of the time has been given to the study of methods of analysis. The methods now used in the examination of tanning materials, leather, paper, and turpentine leave much to be desired both from the standpoint of accuracy and of utility. Several improvements have been made in these particulars.

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The number and character of samples received in the laboratory during the year are shown in the following table:

Papers	139
Tanning materials	124
Turpentine	55
Fertilizers	21
Soils	36
Whiskies	76
Miscellaneous	40
Total	491

CONTRACTS LABORATORY.

The work of this laboratory is divided as follows:

(1) Contracts, consisting of the examination of materials submitted with bids for or furnished upon contract in this Department or other Executive Departments.

(2) Special investigations, consisting of such work as is requested by the other Executive Departments, or as is done for this Department where the interests of the service warrant.

(3) Miscellaneous work, consisting of the examination of substances of a general nature where requested by the different Bureaus of this Department or by the other Executive Departments.

The amount and nature of the work for the past year are summarized in the following table:

Department.	Contract samples.	Samples for special investigations.	Miscellaneous samples.
Agriculture	64	123	31
Commerce and Labor		3	2
Interior	77		
Post-Office	105	80	
Treasury		79	10
War	11	3	2
Total	257	288	45

NOTE.—The foregoing table does not include Treasury sugar samples, of which 548 were examined during the year.

The nature of the contracts work and of the special investigations made for the different Departments was as follows. The miscellaneous samples deserve no special attention.

DEPARTMENT OF AGRICULTURE.

A total of 64 samples of chemical glassware and library pastes were analyzed for this Department for guidance of the board of awards in awarding contracts for these materials. In addition to the above were conducted investigations of glassware, writing inks, and typewriter ribbons, in which investigations a total of 123 samples were examined. The work on glassware has been completed and the information gained has been used as the basis of a series of tests for glassware to determine wearing qualities and resistance to reagents. The work on writing inks and typewriter ribbons has progressed satisfac-

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torily, and reports covering the investigations will be made about September 1. These reports will show that many of the inks and typewriter ribbons now in use in the various Executive Departments are not capable of furnishing records of sufficient permanence. Requirements for these items will be suggested with the view to obtaining more satisfactory material of this class for the Government service.

DEPARTMENT OF COMMERCE AND LABOR.

The samples of life-preservers were examined for this Department to determine their buoyancy, rate of water absorption, and the nature of the material from which they were made.

INTERIOR DEPARTMENT.

A total of 77 samples, consisting of coals, lubricating oils, and disinfectants, were examined for this Department for contracts purposes.

POST-OFFICE DEPARTMENT.

One hundred and five samples, consisting of canceling inks for both rubber and metal stamps, stamping inks, numbering-machine inks (both noncopying and copying), glues, glycerins, inking pads, and postal-card paper, have been examined for this Department for contract purposes. An investigation of rosin oils has also been taken up to determine the fitness of these oils in making canceling inks. Eighty samples of oils were collected for this investigation, and much of the work has already been completed.

TREASURY DEPARTMENT.

During the year ending June 30, 1904, the investigation of soap stocks, machinery oils, finishing soaps, etc., was taken up to determine whether any of these materials were of use as alizarin assistants or substitutes therefor. This work was completed early this year, when 73 samples were reported upon. Recently a number of other samples of this nature have been received for similar examination, and the work is now under way. During the first half of the year 548 samples of sugars were received for analysis. With the exception of 146 samples, this work was largely done in the sugar laboratory under the direction of the chief of this laboratory.

WAR DEPARTMENT.

Eleven samples, largely food products, were examined for this Department for contract purposes, and an investigation of the army emergency ration was made for the purpose of procuring some suitable binding material for this product. After considerable work a binding material was suggested that would enable the ration to be pressed into sufficiently firm cakes and at the same time would not materially affect the composition of the ration.

A total of 590 samples have been examined in this laboratory during the year. There has been a material increase in the amount of contract work requested, and in all cases the laboratory has been able to handle this work promptly.

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MICROCHEMICAL LABORATORY.

The first four months of the past fiscal year were spent in connection with the exhibit of the Bureau of Chemistry at the Louisiana Purchase Exposition at St. Louis, Mo. For nearly three months of that time the chief of the laboratory was the representative of the Bureau in charge of the exhibit. During the most of the time while with the exhibit there were given daily two public lectures describing the work of the Bureau of Chemistry, illustrated by lantern slides and also by microprojection of the samples upon the screen.

Another feature of the work involving considerable attention was that of answering inquiries concerning laboratory equipment and methods. This included conversations of a popular nature with visitors who knew little or nothing of the work of the Bureau and whose interest had been aroused by the exhibit. The second class of conversations was with instructors, both of chemistry and allied branches of science, as to apparatus and methods.

As a result of this feature of our work at the exposition, this laboratory, in collaboration with the Division of Foods, has completed a limited number of sets of samples for distribution to instructors of domestic science and food-analysis methods.

A number of samples of food products were examined for the juries of awards at the exposition.

What time could be obtained aside from the above lines of work was given to the regular work of the laboratory in the line of microscopical examination of samples and research work.

The regular work of the laboratory has of necessity been largely cooperative with the other laboratories of the Bureau or with other bureaus or branches of the Government. As a result, extremely little research work of a strictly independent character has been done.

The work upon the microscopical features of the starches has been continued as time and opportunity allowed, until at present our collection of photo-micrographs includes those of about 50 kinds.

The largest part of the collaborative work has been with the Division of Foods in connection with the hygienic table work, which involved the examination of a large number of urine and blood samples. Besides these there were examined samples of mustard, chocolate, pepper, coffee, and other miscellaneous food samples.

In collaboration with the Insecticide and Agricultural Water Laboratory nearly 300 cattle foods have been examined to determine as far as possible, from a microscopical analysis, of what ingredients they are composed.

For the Leather and Paper Laboratory has been examined a number of papers and paper materials and fabrics.

In cooperation with the Drug Laboratory a number of medicinal and drug samples have been examined to identify as far as possible the ingredients present.

For the Contracts Laboratory there have been examined miscellaneous samples, such as typewriter ribbons, emergency rations for the Army, and lampblack.

There were also examined some samples of a miscellaneous character, besides the making of a series of photo-micrographs for the Division of Tests, part of one set having already been used for illustrating Bulletin No. 92.

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During the year there has been prepared a manuscript for the microscopic part of the forthcoming bulletin upon the ripening of apples.

During the present season microscopic work upon barleys has been begun in connection with chemical studies which are being conducted by other branches of the Bureau.

In condensed form the following will give some idea of the work of the laboratory during the year ended June 30, 1905:

Samples examined:	
For Division of Foods	384
For Insecticide and Water Laboratory	290
For Contracts Laboratory	61
For Leather and Paper Laboratory	15
For Drug Laboratory	25
Miscellaneous samples:	
For jury of awards Louisiana Purchase Exposition	99
Other samples	61
Total samples examined	935
Photographic negatives made:	
Macroscopic	41
Photomicroscopic	114
Total	155
Stereopticon lectures at Louisiana Purchase Exposition, about	200

DAIRY LABORATORY.

In this laboratory there have been analyzed or otherwise examined during the present fiscal year 253 samples, of which 129 were in connection with the work of this Bureau, most of them being samples of milk and butter used at the hygienic table for the investigation of the physiological effects of preservatives in food; 63 were from the Bureau of Animal Industry, mostly in connection with the work of enforcing the renovated butter laws; 14 were examined for the War and State Departments in connection with food supply for the Army and with certain butters of suspicious character exported from this country, and 47 were miscellaneous samples examined for parties other than those named above or used in investigations carried on by this laboratory. The investigations have included:

(1) A study of butters produced by heavy feeding of cotton-seed products, such butters often bearing a strong resemblance to adulterated butter. An authenticated sample of such a butter, produced by Mr. Fred H. Smith, of Fairbanks, Tex., by the heavy feeding of cotton-seed meal and hulls, was procured by the Dairy Division of the Bureau of Animal Industry. It was examined, with the following results:

Melting point	°C.	41.7
Volatile acids, Reichert-Meissl number		25.5
Saponification number		220
Insoluble acids	per cent	89
Soluble acids, as butyric	do	5.37
Iodin number		8
Mean molecular weight of insoluble acids		7

The Halphen test for cotton-seed oil [illegible] from 1 to 2 per cent of that oil in the



not strictly normal, aside from its content of cotton-seed oil, could hardly be regarded as adulterated.

(2) Examination of proposed methods for the rapid estimation of water in butter, in the hope of finding some method of use to creameries and renovating factories for controlling the amount of water in this output.

These methods as originally proposed were applied to unsalted butter, and therefore are not applicable to butters as generally found on the markets in this country. A modification of the process to apply to such butters was perfected, which gives fairly good results for factory purposes. The more rapid conduct of the common method, which consists in using a higher temperature and thus shortening the time for complete desiccation, is found to give more satisfactory and quite as speedy results for factory control.

(3) Examination of methods proposed for the detection of moderate or slight adulteration of butters. The only one of these methods that we have studied thoroughly is that which consists in rapidly stirring 5 or 10 grams of the suspected butter with a large quantity of milk (500 or 1,000 cc), held at the temperature of 37.5° C. The sample must not have been previously melted. Butter fat, it is claimed, will under the stated conditions readily emulsify with the milk and disappear therein in the form of small globules, while foreign fat will remain on the surface of the milk as an unemulsified residue, to be separated from the emulsion by running the latter through a sieve and to be then examined by the refractometer. It has been assumed that if any such residue is left from the treatment of pure butter it will show the same refractive power as did the original butter fat, and it has therefore been maintained that, whenever a residue shows a higher refractive power than did the original fat therein, this is proof that the butter was adulterated. We have studied this method carefully, but failed to obtain definite results. While it is true that adulterated butters will yield an unemulsified residue showing higher refractive power than did the original material, so also will pure butters, and we have obtained as great a difference between the refraction of the residue and the original material in the case of an undoubtedly pure butter as in the case of a butter adulterated in the laboratory with 10 per cent of oleomargarine, the latter having been worked into the butter by ladling them together while in a soft condition.

SECTION OF CHEMICAL ŒNOLOGY.

Our work in this important field of investigation was vigorously continued during the year. The pure cultures of yeast for the production of cider of predetermined chemical composition were continued and small quantities of these cultures were distributed to those interested in the manufacture of cider in Virginia, Pennsylvania, New York, Ohio, Missouri, Idaho, and Delaware.

Cooperative experiments in the control of the chemical composition of the cider produced were carried on in practical manufacture in Crozet, Va., and Dover Plains, N. Y.

A large number of letters of instruction and suggestion were sent to inquiring parties engaged in the cider industry throughout the United States.

The results of the investigations conducted during the year are almost ready for publication.

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CLERICAL WORK.

The amount of clerical work performed in the Bureau of Chemistry during the fiscal year ended June 30, 1905, may be summarized as follows:

Approximate number of typewritten letters	16,000
Approximate number of typewritten pages other than letters	3,000
Requisitions	1,400
Calculations in connection with hygienic table	250,000

The above tabulation does not include a large number of circular letters, a vast amount of work on the various card catalogues of the Bureau, or the work of receipt and disbursement of supplies and the checking of the accounts of the Bureau.

PUBLICATION WORK.

The publications and miscellaneous printing of the Bureau for the past year were as follows:

NEW PUBLICATIONS.

BULLETINS.—No. 83, Part II, Foods and Food Control, Legislation during year ended July 1, 1904; No. 84, Influence of Food Preservatives and Artificial Colors on Digestion and Health, Part I, Boric Acid and Borax;[a] No. 85, The Cementing Power of Road Materials; No. 86, Arsenic in Papers and Fabrics; No. 87, Chemical Composition of some Tropical Fruits and their Products; No. 88, The Chemical Composition of Apples and Cider; No. 89, Injury to Vegetation by Smelter Fumes; No. 90, Proceedings of the Twenty-first Annual Convention of the Association of Official Agricultural Chemists (in press); No. 92, The Effect of Water on Rock Powders; No. 93, Experiments in the Culture of Sugar Cane and its Manufacture into Table Sirup (in press); No. 94, Studies on Apples (in press); No. 95, The Influence of Environment upon the Composition of the Sugar Beet, 1903 (in press); No. 96, The Influence of Environment upon the Composition of the Sugar Beet, 1904, together with a Summary of the Five Year Experiment (in press). Approximate total number of pages, 1,182.

CIRCULARS.—No. 17, The Useful Properties of Clays; No. 18, Suggestions to Importers of Food Products; No. 19, Methods for the Detection of Renovated Butter; No. 20, Extracts from the Proceedings of the Association of Official Agricultural Chemists, 1904; No. 21, Proposed Regulations Governing the Labeling of Imported Food Products; No. 22, Cooperative Work on the Titer Test, Association of Official Agricultural Chemists, 1904; No. 23, Methods for the Examination of Maple Products; No. 13, of the Secretary's Office, Standards of Purity for Food Products. Total number of pages, 80.

FOOD INSPECTION DECISIONS, Nos 1 to 25 (in press). Number of pages, 25.

ARTICLES IN 1904 YEARBOOK.—Inspection of Foreign Food Products; Detection of Cotton-Seed Oil in Lard, Food Legislation and Inspection. Total pages, 23.

Total number of pages of original matter prepared for publication, 1,310.

PUBLICATIONS REPRINTED.

BULLETINS.—No. 81, Proceedings of the Twentieth Annual Convention of the Association of Official Agricultural Chemists, 1903; No. 83, Foods and Food Control, Part I, Legislation during the year ended July 1, 1903; No. 71, A study of Cider Making in France, Germany, and England, with Comments and Comparisons on American Work; No. 70, Manufacture of Table Sirups from Sugar Cane (twice); No. 46 (revised), Methods of Analysis; No. 65, Provisional Methods for the Analysis of Foods; No. 68, The Chemical Composition of Insecticides and Fungicides; No. 69, Parts I to V, Foods and Food Control; No. 77, Olive Oil and its Substitutes; No. 88, The Chemical Composition of Apples and Cider; No. 74, The Influence of Soil and Climate upon the Composition of the Sugar Beet; No. 13, Foods and Food Adulterants, Part X, Preserved Meats.

[a] Reported as "in press" in report of 1904; not included in total for 1905.

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CIRCULARS.—No. 14, Organization of the Bureau of Chemistry; No. 15, Results of the Borax Experiment; No. 20, Extracts from the Proceedings of the Association of Official Agricultural Chemists, 1904; No. 12 (revised), Methods for the Investigation of Canceling Inks and other Stamping Inks.

MISCELLANEOUS.—Farmers' Bulletin No. 52, The Sugar Beet—Cultivation, Seed, Development, Manufacture, and Statistics; Report of Cooperative Work on the Dalican Titer Test (separate from Bulletin 81); The Selection of Materials for Macadam Roads (Yearbook, 1900); The Adulteration of Drugs (Yearbook, 1903); Determination of the Effect of Preservatives in Food on Health and Digestion (Yearbook, 1903); Report of the Chemist, 1904.

Total number of pages of reprints, 1,880.

JOB PRINTING.—A total of 222 orders distributed approximately as follows: Miscellaneous (index cards, announcements Association of Official Agricultural Chemists, forms for food-table work, labels, etc.), 120; drawings and blueprints, 31; stationery, 53; circular letters, 18.

OUTLINE OF WORK FOR THE FISCAL YEAR ENDING JUNE 30, 1906.

DIVISION OF FOODS.

The work of the Division of Foods will be largely devoted to experiments relating to the influence of preservatives on health and to the enforcement of the imported-food law. The former study will occupy the attention of by far the greater part of the force of the Division of Foods located in Washington for about eight months of the year, and of a portion of the force for the whole year.

During the fiscal year ending June 30, 1906, almost all of the analytical work connected with the enforcement of the foreign-food law will be conducted in the port laboratories which are already in operation in New York and San Francisco, and are being installed in Boston, Philadelphia, Chicago, and New Orleans. The work of the Washington laboratory in connection with the enforcement of the imported-food law will be confined to checking the work of the port laboratories and to certain studies of analytical methods for the purpose of establishing standards.

The study of the changes of composition of fruit during ripening will be continued with special reference during the summer to the orange and persimmon. Attention will also be given to a number of problems connected with the storage of fruit.

The vinegar and cod-liver oil studies inaugurated during the last fiscal year will be continued. The collaborative work on the Dalican and Belfield tests for the detection of beef stearin in lard and the cold test will be continued during the coming year.

Work will also be continued on the most available methods for the detection of food preservatives, and on the natural occurrence of those preservatives in articles of food. The study relating to the composition of distilled liquors will be continued, and after its conclusion the composition of other articles of food will be carefully studied with a view to securing data for establishing standards to enable us to judge more intelligently of the purity of commercial samples.

PLANT ANALYSIS.

So far as facilities will admit, the work for next year will be in collaboration with the Bureau of Plant Industry. This will begin with the collaborative cereal work, and the extension of the work now under way will be attempted.

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Second in importance will be the continued study of the cassava plant with the purpose of selecting for propagation the best from the imported stock.

Twelve of these varieties were selected from forty pedigreed varieties during the past year and grown under actual field-culture conditions. It is intended to determine the actual yield of each variety in starch by milling tests; also to make experiments upon the cost of drying ground cassava and ascertaining its value for food or stock purposes in the open market. The study of this plant is to be taken up in other of the Gulf States.

Some collaborative work upon practical hemp retting is planned, the experiments to consist of the vat retting of green hemp. The fiber from green hemp is white and of a very fine texture, making the highest grade of linen.

Further collaboration, which will be arranged to such extent as the resources of the laboratory permit, will be on the study of cotton in connection with the improved varieties which are being developed by the Bureau of Plant Industry, some collaborative experiments in the fertilization of fruits, and some forage crop studies.

CEREAL SECTION.

Over one hundred samples of the best varieties of wheat found in Algeria, France, Italy, Russia, and elsewhere are on hand ready for analysis. This is part of the cooperative work with the Bureau of Plant Industry. Samples of these same wheats have been planted in various parts of this country having different climatic conditions, and it is expected to have the crops analyzed, so that in several years most valuable data will be secured concerning the effect of environment on the composition. This same kind of work is to be taken up with other cereals, e. g., rye, barley, oats, and corn.

When durum wheats are grown in this country white spots appear on the seed, the effect of which is to make a less readily salable, and therefore a less valuable, article. It is estimated that this white spot causes a loss of hundreds of thousands of dollars to the farmers, because the price per bushel of such wheat is about 2 cents less. Experiments have already been started in a preliminary way to study the causes and prevention of these white spots.

The rôle which organic phosphorus plays in the animal organism is still, in some respects, an unsettled question, and one of great importance. To study this question still further, it is the intention to inaugurate a series of experiments with small animals, feeding them organic and inorganic phosphorus compounds.

The work on the composition of barley and malt and its relation to the character of beer will be continued.

The influence of latitude on the sugar content of sweet corn will be studied, the same variety of corn being grown in various States, from South Carolina to Maine.

It is also intended to continue the work on the separation of amido bodies and their determination.

The contemplated work for the coming year and the work that has been begun under the new plan of cooperation between Cereal Investigations of the Bureau of Plant Industry and the Bureau of Chemistry is as follows:

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(1) Continuation of the aforementioned lines of work.

(2) A study of the nitrogenous constituents of barley and malt, with special reference to malting and beer making qualities, and also a study of the ash constituents of the same materials.

(3) A study of the composition and feeding value of the seeds or grain of sorghum, milo maize, Kafir corn, etc., in relation to problems of plant breeding and selection, carried on by Cereal Investigations of the Bureau of Plant Industry.

MICROCHEMICAL LABORATORY.

The work outlined for the year includes a continuation of the work begun this year upon barleys in conjunction with the cereal section. It is hoped to finish the examination of poultry and stock foods and take up the examination of imported samples of sumac used as sources of tannin, which have been collected during the past year by the Leather and Paper Laboratory. Miscellaneous samples from the various laboratories, especially drugs, will also be examined.

DRUG LABORATORY.

The work planned for the year beginning July 1, 1905, is a continuation of the investigations instituted in this laboratory and given in detail in the report of work for the past fiscal year, together with an examination of medicinal chemicals. The work can be briefly summarized as follows:

CHEMICAL REAGENTS.—Examination in the Bureau of Chemistry for the purpose of collecting data for standards and insuring the securing of reliable chemicals for analytical work.

PLANT DRUGS.—Study of quality, purity, keeping qualities, and an examination of the analytical methods at present in use.

COD-LIVER OIL INVESTIGATION, with a view of determining in what manner the American oils differ from the Norwegian; and, if they differ, what the causes of such differences are and how they may be eliminated.

PROPRIETARY MEDICINAL AGENTS.—Examination of these remedies so as to supply the Post-Office Department with the desired information relative to fraudulent medicines; to cooperate with the American Medical Association, and to supply recognized officials with proper data.

EXAMINATION OF COMPOUNDED OILS AND ESSENCES, used for the extemporaneous manufacture of liquor of any "age" from raw spirits.

PLANT ANALYSIS, to determine the medicinal value of indigenous plants which are represented as having great curative properties.

DRUG LEGISLATION.—To supply full and authentic information on the subject of laws regulating drug adulteration.

MEDICINAL CHEMICALS.—This line of work is expected to be instituted with the advent of the next revision of the United States Pharmacopœia, which is to become effective August 1, 1905.

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DAIRY LABORATORY.

The work for this laboratory for the year will be as follows:

(1) Continuation of work along the lines described in the account of last year's work.

(2) Cooperative work with the Bureau of Animal Industry on the digestibility of Cheddar cheese when ripened at different temperatures and for different lengths of time.

CONTRACTS LABORATORY.

It is proposed that the work on writing inks be continued along different lines from those which have been followed during the past year, that the examination of typewriter ribbons be completed, and that the investigation of typewriter carbon papers be taken up, the examination of carbon papers to be for the purpose of ascertaining their fitness for record work. It is further proposed to make a study of the printing inks in use in the various branches of the Government service with a view to ascertaining the effect of the different inks on papers, and consequently on the permanence of printed public documents.

The contract work for the various Departments, and especially our own Department, should be greatly extended. All supplies suitable thereto should be submitted to chemical analysis. Among these may be mentioned coals, lubricating oils, paints and painters' supplies, writing inks, carbon papers, typewriter ribbons, etc.

MISCELLANEOUS LABORATORY.

[Formerly Insecticide and Agricultural Water Laboratory.]

During the year ending June 30, 1906, the examination of irrigation waters for the Office of Irrigation Investigation will be continued.

The study of the composition of American mineral waters will be pursued, giving especial attention to these waters as they come from the ground rather than as they appear on the market. This investigation will be carried out in collaboration with the Hydrographic Office of the United States Geological Survey.

The work on insecticides in connection with the Bureau of Entomology will be continued and studies of the composition and methods of analysis of certain insecticides will be continued. It is hoped that with the data now on hand and such as will be obtained during the next six months a bulletin on Insecticide Studies will be ready before the end of the year.

A study of the methods of determining various constituents in the common disinfectants will be undertaken in the hope of improving the same.

The work on the composition of American cattle foods will be continued. It is hoped that a bulletin on this subject can be issued during the year.

The analysis of malts and barleys will also be continued.

In collaboration with the Bureau of Forestry, a study will be made of the injury to vegetation by smelter furnaces similar to the study recently made in California for the United States Department of Justice.

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If time allow, certain hygienic studies similar to the bulletin on "Arsenic in papers and fabrics," recently published from this laboratory, will be undertaken.

Besides the above, this laboratory will from now on have charge of all the miscellaneous work of the Bureau which does not properly belong to any of the other laboratories.

LEATHER AND PAPER LABORATORY.

Because it is necessary to devise and improve methods for much of the work, which is along new lines, progress has been slow, and the work now on hand will be sufficient to occupy the time of the laboratory force during the coming year.

The following is the proposed scheme of work for the fiscal year 1906 in detail:

(1) Study of the extraction of tannin from tanning materials, with a view to reducing materially the large losses in this process. From one-eighth to one-third of the tannin contained in bark and other tanning materials is now lost annually.

(2) Study of quick-growing or hitherto but little used tanning materials for the purpose of determining their leather-making value, and also their susceptibility to improvement with a view to supplementing the rapidly decreasing supply of materials now generally used.

(3) Investigation and valuation of degras or wool grease, and of methods for the detection of its adulterants.

(4) Investigation of the physical and chemical qualities of various leathers.

(5) Investigation of the chemical and physical properties of the more important kinds of papers and from these and other data the preparation of the standard specifications for papers designed for various uses.

(6) Investigation of new raw materials for pulp and paper making and demonstration of the value of such materials.

(7) Investigation of the distillation of turpentine, with particular reference to improving the yield and quality of the product from waste pine.

(8) Investigation of the adulteration of turpentine.

(9) Investigation of the destructive distillation of wood.

This laboratory will hold itself in readiness to cooperate, so far as its facilities will permit, with the other Bureaus and Divisions of this and other Departments in work which comes within its province.

PROPOSED WORK IN CHEMICAL ŒNOLOGY.

The investigations in chemical œnology are to be continued in practically the same lines as heretofore. More attention, however, will be devoted in the future to the chemical control in the production of wine. This work will render necessary collaboration with those interested in the wine and cider industries in different localities, in order that practical skill may be combined with the chemical control and the work may be conducted with the least expense and lead to the most valuable results.

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REPORT ON NEW DEPARTMENT BUILDINGS.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF CHAIRMAN OF BUILDING COMMITTEE,
Washington, D. C., October 1, 1905.

SIR: I have the honor to submit herewith a brief statement covering the work for the year on the new buildings for the Department of Agriculture, authorized by the act of Congress approved February 9, 1903.

Respectfully,

B. T. GALLOWAY,
Chairman, Building Committee.

Hon. JAMES WILSON, *Secretary.*

ORGANIZATION.

The work on the new buildings for the Department of Agriculture has been carried on during the past year by the building committee appointed May 14, 1903, which consisted of Dr. D. E. Salmon, Chief of the Bureau of Animal Industry; Dr. A. C. True, Director of the Office of Experiment Stations, and the writer, who, having been designated as chairman of the committee, has in such capacity made all necessary recommendations, prepared requests for authorizations, requisitions, etc., and attended to the necessary details connected with the work.

The general construction work has been in charge of John Stephen Sewell, captain, Corps of Engineers, U. S. Army, and the mechanical equipment in charge of Mr. R. Barnard Talcott and Mr. S. Franklin Gardner, assisted by Mr. H. L. Gilbert. Mr. J. G. Palmer was appointed January 1, 1905, inspector on the work under Captain Sewell. Assistant inspectors, Mr. L. B. Roberts and Mr. J. M. Thompson, were appointed on July 10, 1905, and August 1, 1905, respectively, and on August 10, 1905, Mr. L. F. Eaton was appointed as inspector of the new sewer.

GENERAL CONSTRUCTION.

After a careful study of the Department requirements by the building committee and the architects selected for the work, Rankin, Kellogg & Crane, of Philadelphia, drawings and specifications were prepared for two L-shaped laboratory structures, each approximately 256 feet long by 60 feet wide, and each having a rear wing 100 feet long by 60 feet wide, extending to B street southwest, the laboratory buildings being symmetrically arranged, one on each side of the proposed administration building, to be centered on Thirteenth street,

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the axis of the present administration building. Tentative plans for the new administration building were also prepared, providing for connecting corridors to each of the laboratory buildings, the administration building and the laboratory buildings having a frontage facing the Mall of approximately 750 feet.

Twenty bids were received November 10, 1904, for the general construction of the two laboratory buildings, and the contract for this work was awarded December 14, 1904, to the lowest bidder, Mr. Ambrose B. Stannard, of New York, the buildings under this contract to be constructed of Milford pink granite for base and Vermont marble for superstructure.

The excavations, erection of a full-sized model, construction of superintendent's offices, fence around site, etc., were begun at once, and the work progressed in a satisfactory manner until February 25, 1905, when the contractor was ordered to stop work on the excavations, pending a decision in reference to changes in location of the buildings suggested by the Park Commission, which were brought to the attention of the building committee by the architects. The suggestion of the Park Commission was that the buildings be located to conform more fully with the scheme for the improvement of the Mall, to accomplish which result it was necessary that the buildings be located approximately 106 feet farther west and lowered 7 to 10 feet below the requirements of the existing contract, the object being to locate the buildings centrally between Twelfth and Fourteenth streets southwest and to have the base of the buildings approximately on line with the base line of future buildings to be built along the Mall.

At a meeting of the building committee on March 6, 1905, the changes in question were discussed, the approximate extra cost of the changes, $36,000, was determined, and the results were laid before the Secretary of Agriculture. All the questions unsolved were then considered by the President, the Secretary of Agriculture, the Park Commission, and the architects, and it was decided to lower the buildings 10 feet and center the same between Twelfth and Fourteenth streets southwest. The work was therefore resumed on April 3, 1905.

Since that date rapid progress has been made. The excavations have been completed, foundations installed, subbasements constructed, basement floors placed, and in one of the buildings the granite work and basement walls and partitions are practically completed, while this work on the other building is well started. All work in place and all materials furnished have been carefully and thoroughly inspected by the supervising engineer and the inspectors on the work. The architects have furnished all necessary full-sized detail drawings, and have given their supervision to the erection and modification of the full-sized model and to all matters affecting the artistic portion of the work.

NEW SEWER.

The lowering of the buildings made necessary the construction of a sewer from the site of the buildings at the south end of the Department grounds to the canal sewer on B street northwest. Drawings and specifications were prepared under the direction of the supervising engineer for an 18-inch diameter main sewer with

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12-inch diameter branch connections from each of the new buildings. This work was advertised under date of June 28, 1905, and on August 1, 1905, four proposals were opened covering this work. After consideration of the bids, the committee recommended the acceptance of the proposal of the lowest bidder, the R. J. Beall Construction Company, whose bid, based upon the probable quantities, was, in amount, $6,890.30, and the work was awarded to this company under contract dated August 9, 1905. This work was immediately started and at the present time the 18-inch sewer main is practically completed and the 12-inch branch connections are under construction.

MECHANICAL EQUIPMENT WORK.

Working drawings and specifications for the complete mechanical equipment, including heating and ventilation, electric lighting, telephone, bell, and standard clock systems, and a special system of piping for the various laboratory requirements, have been completed under the direction of the mechanical engineers, and contracts for this work will be awarded this winter, so that the installation of the work can be begun in the early spring.

By the relocating of the buildings, the site previously determined upon for the power plant at the southwest corner of the grounds had to be abandoned, and there is now no available site for a permanent power house on the Department grounds in the vicinity of the new buildings. If, however, Congress favorably considers the central power plant for the Government buildings on the Mall, as covered by the report of Mr. Bernard R. Green, dated January 9, 1905, the Department will not need to construct a power plant, and the committee is awaiting action on the above report before making definite recommendations relative to the location of a Department power plant.

FINANCIAL STATEMENT.

The contract with Mr. Stannard as accepted December 14, 1904, including the two alternate proposals, one for terra-cotta floor construction and the other for the omission of all marble wainscoting in corridors, was, in amount, $1,171,000. By a supplementary agreement dated February 14, 1905, proposals in the nature of deductions, in total amount $14,750, were accepted for substituting reinforced concrete floor construction in lieu of terra-cotta arch construction, the substitution of Portland cement in lieu of La Farge cement, and for a change in the granite work at the west end of Laboratory A and corresponding end of Laboratory B, the latter changes being desired by the architect to conform with a revised design of proposed connecting corridor from the laboratory building to the proposed administration building. By another supplemental agreement, dated June 26, 1905, an addition was made to the contract of Mr. Stannard, in amount $37,511.84, to cover items of increase in cost for additional excavating, concrete paving, etc., necessitated by the changes in location of the buildings. These changes also required certain modifications in the plumbing systems of the buildings, the omission of considerable granite work, area rail-

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ings, etc., and these items will form another supplemental agreement in the nature of a proposal for deduction, the total amount of which is estimated at $7,961.54. The amount of the contract of Mr. Stannard, including the executed supplemental agreements, is therefore $1,193,761.84.

Statement of account, new building fund, to October 1, 1905.

Expenditures:		
On contract with Ambrose B. Stannard		$135,601.65
On contract with R. J. Beall Construction Company		4,160.05
For architects' fees		42,483.22
For construction of superintendent's quarters		1,377.85
For salaries, tests, moving buildings, supplies, and incidentals		14,404.97
Liabilities for requisitions, etc		136.81
Total		198,164.55
Appropriations:		
March 3, 1903	$250,000	
March 3, 1905	700,000	
		950,000.00
Total expenditures and liabilities		198,164.55
Balance available October 1, 1905		751,835.45

RECOMMENDATIONS.

Because of the rapid growth of the Department, it is now still more apparent than it was a year ago that the buildings under construction can not begin to adequately accommodate the various branches of the Department now occupying very undesirable and poorly equipped buildings. It is therefore again earnestly recommended that an effort be made to secure at the next Congress an appropriation of not less than $1,500,000 for the proposed administration building, tentative plans for which have already been prepared. This building is absolutely necessary in order that the executive offices of the Department may be housed in suitable quarters for proper and most efficient service.

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REPORT OF THE APPOINTMENT CLERK.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE APPOINTMENT CLERK,
Washington, D. C., September 30, 1905.

SIR: I have the honor to submit herewith my annual report respecting the officers, employees, etc., constituting the body of the United States Department of Agriculture as it existed on July 1, 1905, and various addenda relating thereto.

Very respectfully,

J. B. BENNETT,
Appointment Clerk.

Hon. JAMES WILSON, *Secretary.*

OFFICERS AND EMPLOYEES.

In the following tables are shown the number of officers and employees in the Department, the changes that occurred during the year, the amount paid for salaries, and the distribution of the force among the various bureaus, divisions, and offices.

Summary of appointments and other changes in employees in the United States Department of Agriculture during the fiscal year ended June 30, 1905.

IN THE CLASSIFIED SERVICE.

Probational appointments	493
Absolute appointments	434
Reinstatements	37
Transfers to this Department	546
Transfers from this Department	18
Promotions	683
Reductions	58
Temporary and emergency appointments	[a] 423
Failures to accept appointments	40
Separations by resignation	270
Separations by termination of appointment	184
Separations by removal	17
Separations by death	24
Excepted positions:	
Appointments	347
Promotions	146
Separations	264

IN THE UNCLASSIFIED SERVICE.

Appointments in the District of Columbia	40
Promotions in the District of Columbia	43
Reductions in the District of Columbia	4

[a] Of these appointments many expired by limitation.

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Separations in the District of Columbia	38
Appointments outside of the District of Columbia	47
Promotions outside of the District of Columbia	13
Reductions outside of the District of Columbia	0
Separations outside of the District of Columbia	42
Temporary (emergency) appointments in the District of Columbia	140
Separations of temporary (emergency) appointees in the District of Columbia	143

Number of persons employed in the different bureaus, divisions, and offices on July 1, 1905.

Office of the Secretary	115
Weather Bureau	1,540
Bureau of Animal Industry	1,475
Bureau of Plant Industry	509
Forest Service	939
Bureau of Chemistry	97
Bureau of Soils	130
Bureau of Statistics	155
Bureau of Entomology	88
Bureau of Biological Survey	37
Division of Accounts and Disbursements	22
Division of Publications	166
Library	16
Office of Experiment Stations	116
Office of Public Roads	41
Total number of persons on rolls July 1, 1905	5,446
Total number of persons on rolls July 1, 1897	2,443
Increase in eight years	3,003

Number of scientists, scientific experts, assistants, and agents on the rolls of the Department on July 1, 1905, and on July 1, 1897, with the increase.

On July 1, 1905:		
Bureau of Plant Industry	310	
Bureau of Soils	93	
Bureau of Animal Industry	1,025	
Bureau of Biological Survey	28	
Bureau of Statistics	63	
Bureau of Chemistry	61	
Bureau of Entomology	57	
Forest Service	180	
Weather Bureau	402	
Office of Public Roads	29	
Office of Experiment Stations	78	
		2,326
On July 1, 1897:		
Weather Bureau	266	
Bureau of Animal Industry	504	
Other Divisions and Offices	155	
		925
Increase in eight years		1,401

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Number of persons employed in the different bureaus, divisions, and offices on July 1, 1905, showing the number employed outside of Washington, D. C., and the number employed in Washington, D. C., and the totals thereof.

Bureau, division, or office.	Number of employees.		
	Outside of Washington, D. C.	In Washington, D. C.	Total.
Office of the Secretary	1	114	115
Weather Bureau	1,348	192	1,540
Bureau of Animal Industry	1,352	123	1,475
Bureau of Plant Industry	157	352	509
Forest Service	753	*186	939
Bureau of Chemistry	21	76	97
Bureau of Soils	----------	130	130
Bureau of Statistics	63	92	155
Bureau of Entomology	43	45	88
Bureau of Biological Survey	11	26	37
Division of Accounts and Disbursements	----------	22	22
Division of Publications	----------	166	166
Library	----------	16	16
Office of Experiment Stations	71	45	116
Office of Public Roads	17	24	41
Total	3,837	1,609	5,446

Distribution of the officers and employees of the Department on the several rolls on July 1, 1905.

Bureau, office, or division.	Number on statutory roll.	Number on rolls paid from lump funds.	Total number on both rolls.
Office of the Secretary	100	15	115
Weather Bureau	178	1,362	1,540
Bureau of Animal Industry	71	1,404	1,475
Bureau of Plant Industry	161	348	509
Forest Service	94	845	939
Bureau of Chemistry	25	72	97
Bureau of Soils	31	99	130
Bureau of Entomology	12	76	88
Bureau of Biology	6	31	37
Division of Accounts	22	----------	22
Division of Publications	140	26	166
Bureau of Statistics	79	76	155
Library	13	3	16
Office of Experiment Stations	26	90	116
Office of Public Roads	10	31	41
Total	968	4,478	5,446

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Statement of amounts paid for salaries to employees by bureaus, divisions, and offices, showing separately the amounts paid to employees on statutory rolls and the amounts paid from lump funds.

Bureau, division, or office.	Amounts paid in statutory salaries.	Amounts paid from lump funds.	Total amounts paid.
Office of the Secretary	$77,860.00	$1,000.00	$78,860.00
Weather Bureau	180,440.00	574,976.37	755,416.37
Bureau of Animal Industry	87,880.00	1,252,011.10	1,339,891.10
Bureau of Plant Industry	63,430.00	375,452.79	438,882.79
Bureau of Forestry	37,140.00	409,309.60	446,449.60
Bureau of Chemistry	14,800.00	78,890.55	93,690.55
Bureau of Soils	44,680.00	111,874.04	156,554.04
Bureau of Entomology	12,450.00	37,850.74	50,300.74
Division of Biological Survey	17,850.00	22,202.17	40,052.17
Division of Accounts and Disbursements	24,350.00	.....	24,350.00
Division of Publications	30,640.00	96,295.76	126,935.76
Bureau of Statistics	57,760.00	101,308.71	159,068.71
Library	10,200.00	1,659.83	11,859.83
Office of Experiment Stations	.....	120,695.82	120,695.82
Office of Public Road Inquiries	.....	25,398.10	25,398.10
Total	659,480.00	3,208,925.58	3,868,405.58

Paid from lump funds	$3,208,925.58
Paid from statutory rolls	659,480.00
Total	3,868,405.58

During the year ended June 30, 1905, there were recorded 24 deaths among the officers and employees of the Department—11 in Washington and 13 outside of Washington—as shown in the following table:

Separations by death from the Department during the fiscal year ended June 30, 1905.

Name.	State.	Position.	Bureau, division, or office.	Salary.	Date of death.	Age.
					1904.	
Richard H. Lea[a]	La	Cotton statistical agent.	Bureau of Statistics.	$800	June 16	47
Geo. W. Hay	N. Y.	Clerk	Weather Bureau	1,400	Aug. 11	57
Alfred Day	Iowa	Stock examiner	Bureau of Animal Industry.	900	Aug. 4	47
Caleb B. Farnum	R. I.	Forest assistant	Bureau of Forestry.	1,000	Aug. 17	21
William P. Corsa	Del	Assistant pomologist.	Bureau of Plant Industry.	1,600	Sept. 3	62
Belle Gaston	D. C	Copyist	Weather Bureau	840	Oct. 16	41
Henry E. Alvord	Va	Chief of Dairy Division.	Bureau of Animal Industry.	2,500	Oct. 1	60
Frank Matthews	D. C	Laborer	Weather Bureau	450	Oct. 16	61
Chris M. Raff	Nebr	Stock examiner	Bureau of Animal Industry.	900	Nov. 26	51
William Norrington	Cal	Observer	Weather Bureau	1,200	Dec. 81	55
John A. Harvey	W. Va	Engineer and Captain of Watch.	Office of Secretary	1,600	Dec. 11	64
					1905.	
John H. S. Tabler	D. C	Folder	Division of Publications.	840	Jan. 29	36
Geo. H. Harris	Mass	Special agent	Bureau of Entomology.	1,500	Jan. 15	40
Henry V. Heatley, jr.	Mich	Tagger	Bureau of Animal Industry.	720	Feb. 26	28
Miss Agnes B. O'Brien	Ill	Assistant microscopist.	do	600	Feb. 24	34
Edwin H. Harman	Tex	Special agent	Bureau of Plant Industry.	720	Mar. 14	54
George Lunham	Ill	Stock examiner	Bureau of Animal Industry.	900	Mar. 2	69
Thomas O'Shaughnessy.	Ill	do	do	900	Mar. 16	47
Mrs. Kate Wasson	D. C	Charwoman	Office of Secretary	840	Mar. 25	60
Paul P. Druckemiller	Mo	Clerk	Bureau of Animal Industry.	900	Apr. 4	33
Miss Odie A. King	Minn	Laborer	Division of Publications.	720	Apr. 22	38
Henry L. Davison	D. C	Compositor	Weather Bureau	1,250	May 20	61
Mrs. Emily Werner	D. C	Charwoman	Office of Secretary	480	May 10	58
Arthur W. Edson	Vt	Assistant in physiology.	Bureau of Plant Industry.	1,200	June 23	32

[a] The death of R. H. Lea was not reported during the fiscal year ending June 30, 1904, and is therefore included here.

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GROWTH OF THE DEPARTMENT.

On September 30, 1861, the Agricultural Division of the Department of the Interior, being the immediate predecessor of the United States Department of Agriculture, consisted of nine persons.

The Department of Agriculture was established July 1, 1862, according to the provisions of an act to establish the Department of Agriculture, approved May 15, 1862 (volume 12, chapter 72, pages 387, 388, U. S. Stat. L.).

Growth of the force of the Department from September 30, 1863, to July 1, 1905.

Date.	Number employed.	Date.	Number employed.
1863, September 30	29	1891, July 1[a]	1,577
1867, September 30	99	1893, July 1	1,870
1871, September 30	84	1895, July 1	2,043
1873, September 30	92	1897, July 1	2,444
1875, September 30	90	1899, July 1	2,955
1877, September 30	77	1900, November 16	3,128
1879, June 30	93	1901, July 1	3,888
1881, July 1	108	1902, July 1	3,789
1883, July 1	239	1903, July 1	4,200
1885, July 1	214	1904, July 1	4,504
1887, July 1	328	1905, July 1	5,446
1889, July 1	488		

[a] The large increase on July 1, 1891, resulted from the transfer of the Weather Bureau to the Department of Agriculture on that date.

APPENDIX.

AN ACT PROVIDING FOR THE TRANSFER OF FOREST RESERVES FROM THE DEPARTMENT OF THE INTERIOR TO THE DEPARTMENT OF AGRICULTURE.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Department of Agriculture shall, from and after the passage of this act, execute or cause to be executed all laws affecting public lands heretofore or hereafter reserved under the provisions of section twenty-four of the act entitled "An act to repeal the timber-culture laws, and for other purposes," approved March third, eighteen hundred and ninety-one, and acts supplemental to and amendatory thereof, after such lands have been so reserved, excepting such laws as affect the surveying, prospecting, locating, appropriating, entering, relinquishing, reconveying, certifying, or patenting of any such lands.

SEC. 2. That pulp wood or wood pulp manufactured from timber in the district of Alaska may be exported therefrom.

SEC. 3. That forest supervisors and rangers shall be selected, when practicable, from qualified citizens of the States or Territories in which the said reserves, respectively, are situated.

SEC. 4. That rights of way for the construction and maintenance of dams, reservoirs, water plants, ditches, flumes, pipes, tunnels, and canals, within and across the forest reserves of the United States, are hereby granted to citizens and corporations of the United States for municipal or mining purposes, and for the purposes of the milling and reduction of ores, during the period of their beneficial use, under such rules and regulations as may be prescribed by the Secretary of the Interior, and subject to the laws of the State or Territory in which said reserves are respectively situated.

SEC. 5. That all money received from the sale of any products or the use of any land or resources of said forest reserves shall be covered into the Treasury of the United States and for a period of five years from the passage of this act shall constitute a special fund available until expended, as the Secretary of Agriculture may direct, for the protection, administration, improvement, and extension of Federal forest reserves.

Approved, February 1, 1905.

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[In consequence of the foregoing enactment 523 persons were transferred from the General Land Office, Department of the Interior, to the Forest Service of the Department of Agriculture during the months of February, March, and April, 1905.]

List of Principal Officers in the Several Bureaus, Offices, and Divisions in the Department of Agriculture.

OFFICE OF THE SECRETARY.

James Wilson, confirmed Secretary of Agriculture March 5, 1897.
Assistant Secretary—Willet M. Hays.
Chief Clerk—Sylvester R. Burch.
Solicitor—George P. McCabe.
Appointment Clerk—Joseph B. Bennett.
Private Secretary to the Secretary of Agriculture—Jasper Wilson.
Private Secretary to the Assistant Secretary of Agriculture—H. H. Mowry.
Chief of Supply Division—Cyrus B. Lower.
Engineer and Captain of the Watch—Lewis Jones.

WEATHER BUREAU.

Chief—Willis L. Moore.
Assistant Chief—Henry E. Williams.
Chief Clerk—Daniel J. Carroll.
Editor of Monthly Weather Review—Prof. Cleveland Abbe.
In charge of Barometry Section—Prof. Frank H. Bigelow.
In charge of Instrument Division—Prof. Charles F. Marvin.
Forecast Division—In charge, Prof. E. B. Garriott; assistants, Prof. Alfred J. Henry, Prof. Harry C. Frankenfield.
Chief of Climate and Crop Division—James Berry.
Chief of Meteorological Records Division—William B. Stockman.
Chief of Miscellaneous Division—Edgar B. Calvert.
Chief of Publications Division—John P. Church.
Chief of Ocean Meteorology Division—James Page.
Chief of Supplies Division—Frank M. Cleaver.
Chief of Telegraph Division—Jesse H. Robinson.
Librarian and Climatologist—Herbert H. Kimball.
In charge of Forecast Districts—Prof. Henry J. Cox, Chicago, Ill.; Prof. Alexander G. McAdie, San Francisco, Cal.; District Forecaster Edward A. Beals, Portland, Oreg.; District Forecaster John W. Smith, Boston, Mass.; District Forecaster Isaac M. Cline, New Orleans, La.; District Forecaster Frederick H. Brandenburg, Denver, Colo.; District Forecaster Ferdinand J. Walz, Louisville, Ky.
Inspectors—Norman B. Conger, Detroit, Mich.; Henry B. Hersey, Providence, R. I.

BUREAU OF ANIMAL INDUSTRY.

Chief—Alonzo D. Melvin.
Assistant Chief—A. M. Farrington.
Chief Clerk—Edward B. Jones.
Chief of Dairy Division—Ed H. Webster.
Assistant Chief of Dairy Division—Clarence B. Lane.
Chief of Inspection Division—R. P. Steddom.
Assistant Chief of Inspection Division—Morris Wooden.
Chief of Quarantine Division—Richard W. Hickman.
Editor—James M. Pickens.
Animal Husbandman—George M. Rommel.
Librarian—Beatrice C. Oberly.

Laboratory.

Chief of Biochemic Division—Marion Dorset.
Chief of Pathological Division—John R. Mohler.
Scientific Assistant in charge of Zoological Laboratory—B. H. Ransom.

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Experiment Station.

Superintendent—E. C. Schroeder.
Expert Assistant—W. E. Cotton.

BUREAU OF PLANT INDUSTRY.

Pathologist and Physiologist, and Chief—B. T. Galloway.
Pathologist and Physiologist, and Acting Chief in the absence of Chief—Albert F. Woods.
Chief Clerk—James E. Jones.
Editor—J. E. Rockwell.

Vegetable Pathological and Physiological Investigations.

Pathologist and Physiologist in General Charge—Albert F. Woods.
Laboratory of Plant Pathology—Erwin F. Smith in charge.
Laboratory of Plant Physiology—Karl F. Kellerman, acting, in charge.
Laboratory of Plant Breeding—Herbert J. Webber in charge.
Laboratory of Plant Life History—Walter T. Swingle in charge.
Investigations of Diseases of Orchard Fruits—Merton B. Waite in charge.
Grain Investigations—Mark A. Carleton in charge.
Sugar-Beet Investigations—C. O. Townsend in charge.
Pacific Coast Laboratory—Newton B. Pierce in charge, Santa Ana, Cal.
Mississippi Valley Laboratory—Hermann von Schrenk in charge, Missouri Botanical Garden, St. Louis, Mo.
Subtropical Laboratory—P. H. Rolfs in charge, Miami, Fla.

Botanical Investigations.

Botanist—Frederick V. Coville.
Fiber-Plant Investigations—Lyster H. Dewey in charge.
Botanical Studies of Grasses—A. S. Hitchcock in charge.

Farm Management.

Agriculturist in charge—William J. Spillman.
Diversification Farms—D. A. Brodie in general charge.
Range and Cactus Investigations—David Griffiths in charge.
Gulf Coast Forage-Crop Investigations—S. M. Tracy in charge.
Alfalfa and Clover Investigations—J. M. Westgate in charge.

Pomological Investigations.

Pomologist—G. B. Brackett.
Field Investigations—William A. Taylor in charge.
Fruit Transportation and Storage Investigations—G. Harold Powell in charge.
Fruit District Investigations—H. P. Gould in charge.
Fruit Marketing Investigations—S. H. Fulton in charge.
Grape Investigations—George C. Husmann in charge.

Seed and Plant Introduction and Distribution.

Botanist in Charge—A. J. Pieters.
Agricultural Explorer—David G. Fairchild.
Superintendent of Testing Gardens—W. W. Tracy, sr.
Plant Introduction Garden—P. H. Dorsett in charge, Chico, Cal.
Forage-Plant Introduction—C. V. Piper in charge.
Expert Plant Propagator—George W. Oliver.
Superintendent of Weighing and Mailing Section—R. J. Whittleton.

Arlington Experimental Farm.

Horticulturist in Charge—L. C. Corbett.

Investigations in the Agricultural Economy of Tropical and Subtropical Plants.

Bionomist in Charge—O. F. Cook, Lanham, Md.

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Drug and Poisonous Plant Investigations and Tea-Culture Investigations.

Physiologist in Charge—Rodney H. True.
Expert in Tea-Culture Investigations—Charles U. Shepard, Summersville, S. C.

Dry-Land Agriculture and Western Agricultural Extension.

Agriculturist in Charge—Carl S. Scofield.

Experimental Gardens and Grounds.

Superintendent—E. M. Byrnes.

Seed Laboratory.

Botanist in Charge—Edgar Brown.

FOREST SERVICE.

Forester and Chief—Gifford Pinchot.
Associate Forester in Charge of Forest Measurements—Overton W. Price.
Assistant Forester in Charge of Forest Management—Thomas H. Sherrard.
Assistant Forester in Charge of Dendrology—George B. Sudworth.
Assistant Forester in Charge of Forest Extension—Ernest A. Sterling.
Assistant Forester in Charge of Forest Products—William L. Hall.
Assistant Forester in Charge of Records—James B. Adams.

BUREAU OF CHEMISTRY.

Chemist and Chief—Harvey W. Wiley.
Division of Foods—Willard D. Bigelow.
Sugar Laboratory—Under the direction of the Chief of Bureau.
Dairy Laboratory—G. E. Patrick.
Plant Analysis Laboratory—C. C. Moore.
Miscellaneous Laboratory—John K. Haywood.
Drug Laboratory—Lyman F. Kebler.
Contracts Laboratory—L. S. Munson.
Microchemical Laboratory—B. J. Howard.
Leather and Paper Laboratory—F. P. Veitch.
Chief Clerk—M. T. Read.

BUREAU OF SOILS.

Soil Physicist and Chief of Bureau—Milton Whitney.
Chief Clerk—A. G. Rice.
Soil Chemist—Frank K. Cameron.
Chief of Division Soil Management—Frank D. Gardner.
Scientist in Charge of Soil Survey Work—Jay A. Bonsteel.
Scientist in Charge of Alkali Reclamation Investigations—Clarence W. Dorsey.
Expert in Charge of Tobacco Investigations—George T. McNess.

BUREAU OF STATISTICS.

Statistician and Chief—Assistant Secretary of Agriculture in Charge.
Assistant Statistician and Assistant Chief—C. C. Clark.
Associate Statistician—Victor H. Olmsted.
Chief Clerk—Elmer J. Lundy.
Chief of Division of Foreign Markets—George K. Holmes; Assistant Chief, Frank R. Rutter.
Editorial Assistant and Special European Agent—C. M. Daugherty, London, England.

BUREAU OF ENTOMOLOGY.

Entomologist and Chief—L. O. Howard.
Entomologist—C. L. Marlatt.
Chief Clerk—R. S. Clifton.
In Charge of Breeding Experiments—F. H. Chittenden.

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In Charge of Forest Insect Investigations—A. D. Hopkins.
In Charge of Cotton Boll Weevil Investigations—W. D. Hunter.
In Charge of Cereal and Forage Plant Insect Investigations—F. M. Webster.
In Charge of Deciduous Fruit Insect Investigations—A. L. Quaintance.
In Charge of Apiculture—Frank Benton.

BUREAU OF BIOLOGICAL SURVEY.

Biologist and Chief—C. Hart Merriam.
Assistant Chief—A. K. Fisher.
Assistant in Charge Game Preservation—T. S. Palmer.
Assistant in Charge of Economic Relations of Birds—F. E. L. Beal.
Administrative Biologist—H. W. Henshaw.

OFFICE OF EXPERIMENT STATIONS.

Director—A. C. True.
Assistant Director and Editor of Experiment Station Record—E. W. Allen.
Editorial Staff:
Meteorology, Soils, and Fertilizers—W. H. Beal.
Agricultural Botany and Vegetable Pathology—Walter H. Evans.
Field Crops—J. I. Schulte.
Horticulture and Forestry—C. B. Smith.
Zootechny and Human Nutrition—C. F. Langworthy.
Agrotechny, Dairy Farming, and Dairying—H. W. Lawson.
Economic Zoology, Entomology, and Veterinary Medicine—E. V. Wilcox.
Rural Engineering—S. M. Woodward.
Rural Economics—H. C. Taylor.
Agricultural Education—D. J. Crosby.
Chief of Editorial Division—W. H. Beal.
Chief of Division of Insular Stations—Walter H. Evans.
In Charge of Alaska Experiment Stations—C. C. Georgeson, Sitka.
In Charge of Hawaii Experiment Station—J. G. Smith, Honolulu.
In Charge of Porto Rico Experiment Station—David W. May, Mayaguez.
Expert in Nutrition Investigations—C. F. Langworthy.
In Charge of Respiration Calorimeter Investigations—F. G. Benedict, Middletown, Conn.
Chief of Irrigation and Drainage Investigations—Elwood Mead.
Farmers' Institute Specialist—John Hamilton.
Chief Clerk—Mrs. C. E. Johnston.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Chief and Disbursing Clerk—Frank L. Evans.
Assistant Chief of Division (in Charge of Weather Bureau Accounts)—A. Zappone.
Cashier—M. E. Fagan.

DIVISION OF PUBLICATIONS.

Editor and Chief—George William Hill.
Editor and Assistant Chief—Joseph A. Arnold.
Associate Editor—B. D. Stallings.
Assistant in Charge of Document Section—Robert B. Handy.
Chief Clerk—A. I. Mudd.

LIBRARY.

Librarian—Josephine A. Clark.
Assistant Librarian—Claribel R. Barnett.

OFFICE OF PUBLIC ROADS.

Director—Logan W. Page.
Assistant Director—A. S. Cushman.
Highway Engineer—A. N. Johnson.
Chief of Records—M. O. Eldridge.
Testing Engineer—P. L. Wormeley, jr.
Chief Clerk—J. E. Pennybacker, jr.

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[Form No. 1. May 12, 1905.]

UNITED STATES CIVIL SERVICE COMMISSION.

STATEMENT OF APPOINTEE TO THE POSITION OF EXPERT OR AGENT IN THE DEPARTMENT OF AGRICULTURE.

Every person appointed to the position of Expert or Agent in the Department of Agriculture *will be required to execute this form* in accordance with the following regulations:

1. In pursuance of the provisions of section 3 of Civil Service Rule II, the following regulations governing appointments to excepted positions of agent and expert in the Department of Agriculture are approved:

2. To secure the uniform and proper interpretation of these regulations, the following definitions of the terms agent and expert are adopted:

(*a*) An agent is one who is employed to act for or to represent the Department of Agriculture in some locality or territory outside of Washington and whose duties are of such a temporary or special character or whose compensation is so low as to render it impractical to adequately fill the position by open competitive examination.

(*b*) An expert is one who has such rare, peculiar, or unusual skill or experience in some department or branch of knowledge as to render his qualifications essentially different from or superior to those required by any classified employees in competitive positions, and not likely to be possessed in an equal or superior degree by other persons who might be available for appointment.

3. Whenever the Secretary of Agriculture finds it necessary to appoint an expert or agent, he shall report to the Civil Service Commission in the next monthly report of changes in the Department the nature of the work to be done by such agent or expert, accompanied by a statement of his qualifications as governed by the definitions herein set forth, and with such report, or as soon as practicable thereafter, the Secretary shall furnish to the Commission a statement by the person appointed as such expert or agent, upon a form to be agreed to by the Commission and the Department, showing his experience, education, references, and qualifications. The Secretary shall also furnish to the Commission, in the same form and manner, statements containing similar information relative to the employees of the Department now assigned as experts or agents.

4. These regulations may be amended at any time by the Civil Service Commission in accordance with the civil-service rules, after conferring with the Secretary of Agriculture.

JAMES WILSON,
Secretary of Agriculture.

HENRY F. GREENE,
Civil Service Commissioner.

Instructions.—Complete and comprehensive answers should be made to the following questions. In answers to questions relative to time, give dates and periods of time in years and months as accurately as possible. Number answers to correspond with numbers of questions. All answers should be in ink and in the handwriting of the appointee.

Note.—Agents need not answer questions numbered 8 and 11, but should give a full reply to question No. 12, covering what, in the appointee's opinion, is his fitness for the position in question.

1. What is your full name?
2. Give the month, day, and year of your birth.
3. What is your legal residence? (Give State and county.)
4. What designation has been assigned to the position to which you have been or are to be appointed?
5. Under what bureau, office, service, or division is service to be rendered?
6. At what place or in what locality is your assignment?
7. Describe fully the duties of your assignment.
8. With respect to your general and technical or professional education, state fully and in detail the names and localities of the schools or colleges you have attended and the courses of study pursued by you in each, naming any degree or degrees received by you, and the institution by which conferred. If you have pursued any postgraduate courses of study, state fully what studies and when, where, and for what length of time they were pursued.

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9. State fully and in detail all the practical experience you have had in the occupation to which you have been assigned, or in occupations of a similar character. State (*a*) when, giving dates; (*b*) where; (*c*) by whom you were employed; (*d*) the salary or compensation received; (*e*) the specific nature of your duties in each case. If possible, the names and post-office addresses of five persons under whom or for whom you have worked should be given.
10. State what other employments or occupations you have pursued, or positions you have held, and indicate the nature of the duties performed by you in each case. State when (giving dates), where, how long, and under whom you were so employed.
11. If you have written, edited, or translated any scientific papers, give a list of them, stating when, where, and by whom published. (File copies if possible.)
12. Give any additional facts which may tend to show your fitness for the position to which you have been or are to be appointed.

Orders by the President.

EXECUTIVE ORDER.

No officer or employee of the Government shall, directly or indirectly, instruct or be concerned in any manner in the instruction of any person or classes of persons with a view to their special preparation for the examinations of the United States Civil Service Commission.

The fact that any officer or employee is found so engaged shall be considered sufficient cause for his removal from the service.

THEODORE ROOSEVELT.

THE WHITE HOUSE, *October 31, 1905.*

EXECUTIVE ORDER.

Civil Service Rule XII is hereby amended to read as follows:

RULE XII.—*Removal.*

1. In making removals or reductions, and in other punishment, penalties like in character shall be imposed for like offenses.

2. No person shall be removed from a competitive position except for such cause as will promote the efficiency of the service. When the President or head of an Executive Department is satisfied that an officer or employee in the classified service is inefficient or incapable, and that the public service will be materially improved by his removal such removal may be made without notice to such officer or employee, but the cause of removal shall be stated in writing and filed. When misconduct is committed in the view and presence of the President or head of an Executive Department, removal may be made summarily, and no statement of reasons need be filed.

3. Where a recommendation for removal or reduction in grade or compensation of an officer or employee is made to the head of an Executive Department by a bureau chief or other subordinate officer, the said head of Department may, in his discretion, require that the person sought to be removed be furnished with a statement in writing of the reasons for such action, and be allowed a reasonable time for personally answering the same.

4. The Civil Service Commission shall have no jurisdiction to investigate any removal unless it is alleged that the procedure required by section 2 of Rule XII has not been followed, or that the removal was made for political or religious reasons.

THEODORE ROOSEVELT.

THE WHITE HOUSE, *November 17, 1905.*

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AMENDMENT TO THE CIVIL SERVICE RULES.

SCHEDULE A.—CLASSIFIED POSITIONS EXCEPTED FROM EXAMINATION UNDER RULE II, CLAUSE 3.

Schedule A of the civil service rules is hereby amended by the addition to Section VII of a paragraph which shall be numbered 3, and shall read as follows:

3. Guards, guides, cooks, packers, teamsters, choppers, and skilled laborers, employed temporarily during the season of danger from fires or when other special work requires additions to the regular reserve force. They shall serve only as long as absolutely required, and in no case more than six months in any one year. So far as the Commission may deem practicable, such appointments shall be made from the registers of eligibles for forest ranger.

T. ROOSEVELT.

THE WHITE HOUSE, *December 18, 1905.*

As amended, section 2 of Rule VII will read as follows:

1. Agents, experts, and student assistants for temporary duty employed in making investigations and furnishing information for the Department, as provided by law or under the direction of the head of the Department, which agents, experts, and student assistants shall be borne on the rolls as such and be actually engaged in the duties for which they were appointed, and whose payment has been authorized by law, provided that the salary of such student assistants shall not exceed a rate of $300 per annum each while employed.

2. One statistical agent in each State and Territory where authorized by law.

3. Guards, guides, cooks, packers, teamsters, choppers, and skilled laborers, employed temporarily during the season of danger from fires or when other special work requires additions to the regular reserve force They shall serve only as long as absolutely required, and in no case more than six months in any one year. So far as the Commission may deem practicable, such appointments shall be made from the registers of eligibles for forest ranger.

AMENDMENT TO THE CIVIL SERVICE RULES.

Civil Service Rule VII, section 2, is amended by striking out the word "page" and adding the words "carpenter, cabinetmaker, painter, plumber, plumber's helper, electric wireman, electric lineman, and electrician's helper."

As amended, section 2 of Rule VII will read as follows:

Certification for appointment in the departments or independent offices at Washington shall be so made as to maintain, as nearly as the conditions of good administration will warrant, the apportionment of such appointments among the several States and Territories and the District of Columbia upon the basis of population: *Provided*, That *appointments to the following-named positions shall not be so apportioned*, viz: Plate printer, printer's assistant, skilled helper, and operative in the Bureau of Engraving and Printing; positions in the field service of the military staff departments and at Army headquarters, mail bag repair shop and mail lock repair shop, Government Printing Office, Pension Agency, and local offices in the District of Columbia; apprentice, student, gardener, engraver, carpenter, cabinetmaker, painter, plumber, plumber's helper, electric wireman, electric lineman, and electrician's helper.

T. ROOSEVELT.

THE WHITE HOUSE, *December 19, 1905.*

DEPARTMENT CIRCULAR No. 3.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., May 8, 1905.

To the officers and employees of the Department of Agriculture:

Hereafter when any employee of the Department makes any new and useful discovery or invention of any machine, device, or process connected with the

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work of the Department, through the expenditure of Government time and Government money, you are directed to cause a patent to be applied for on the said discovery or invention through the law officer of the Department. The patent will be taken out in the name of the inventor, without any expense to him, and will allow to any citizen of the United States the use of the patented article or process without payments of royalty.

All employees of this Department are prohibited from patenting any device or process or discovery connected with the work of the Department except in the manner above described.

JAMES WILSON,
Secretary of Agriculture.

DEPARTMENT CIRCULAR No. 4.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., September 25, 1905.

To the officers and employees of the Department of Agriculture:

The following regulations are promulgated for your guidance:

Regulation I.—No officer or employee of the Government who is in a position either to influence the award of a contract with the Department or to cause purchases of supplies to be made for the Department shall be interested in any firm, company, or corporation doing business with the Department.

Regulation II.—Officers or employees who are engaged upon investigations of special industries for the Department shall not be connected with or interested in any firm, company, or corporation whose scope of business includes the industry which the officer or employee is investigating for the Department; and an officer or employee engaged upon the above-described work shall in no case allow his name, his work, or his connection with the Department to be used in promoting or exploiting or selling stock in any firm, company, or corporation, the scope of whose business includes the special industry which such officer or employee is investigating for the Department.

Regulation III.—No officer or employee shall perform or be engaged upon work for private individuals, firms, companies, corporations, or institutions without the written consent of the Secretary, first had and obtained through the chief of the bureau, office, or division in which said officer or employee serves.

The purpose of this regulation is not to prevent officers and employees of the Department from performing proper work, outside of office hours, which does not interfere with or hamper work for the Department, but is designed to afford the Secretary an opportunity to pass upon the kind and quantity of outside work which may be permitted in order that such work shall not impair the usefulness of such officers or employees to the Government.

JAMES WILSON, *Secretary.*

AMENDMENT TO DEPARTMENT CIRCULAR No. 4.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., October 20, 1905.

To chiefs of bureaus, offices, and divisions:

Regulation III of Department Circular No. 4 prescribes that—

No officer or employee shall perform or be engaged upon work for private firms, companies, corporations, or institutions without the written consent of the Secretary first had and obtained through the chief of the bureau, office, or division in which said officer or employee serves.

It is hereby ordered that before transmitting to the Secretary for his consideration the written application of an employee or officer for permission to engage in or continue any nonofficial occupation, the chief of the bureau, division, or office shall indorse upon said application his recommendation in the premises, whether of approval or disapproval.

JAMES WILSON, *Secretary.*

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GENERAL ORDER No. 87.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., October 2, 1905.

To chiefs of bureaus, offices, and divisions:

A Committee on Personnel for the Department is hereby created. The committee will be composed of WILLET M. HAYS, Assistant Secretary of Agriculture; S. R. BURCH, chief clerk of the Department; and GEORGE P. MCCABE, solicitor of the Department.

Each chief of bureau, office, or division is hereby directed to report to the Secretary, for reference to the Committee on Personnel, dereliction of duty and actions prejudicial to the interests of the Department by employees thereof. This report shall be made as soon as the improper act is discovered by or is reported to the chief, and shall be followed by a prompt and full report of the action which has been taken or which is recommended by the chief. The committee shall consider all such cases and shall, when deemed necessary by them, investigate the cases further and make report thereon to the Secretary.

Any employee should report to his chief or to the Secretary any matter which, in the opinion of such employee, should be investigated by the committee. The committee is empowered to summon any employee as a witness.

It is not intended that the Committee on Personnel shall interfere with the maintenance of discipline, or a proper supervision of employees by chiefs of bureaus, offices, or divisions.

All communications to the committee should be addressed "Committee on Personnel, U. S. Department of Agriculture, Washington, D. C."

JAMES WILSON, *Secretary.*

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